A Novel Graphic Syntax: An investigation into how a GPS-enabled wayfinding interface can be designed to visually support urban recreational walkers' situation awareness

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Abstract

GPS-enabled wayfinding interfaces (i.e. digital maps) are now commonly used as wayfinding devices in urban locations. While these wayfinding interfaces provide increasingly accurate geographic and routing information, little attention has been paid to how *novel* information design approaches may support particular user-experiences within particular use-contexts.

This practice-based research focuses on the design of GPS-enabled wayfinding interfaces within the use-context of urban recreational walking/wandering. In particular, it investigates how these interfaces could be designed to visually support situation awareness in use. That is, awareness of one's embodied involvement in the surrounding environment while *using* the interface.

The enquiry progresses through two phases.

In the first phase, a programme of semi-structured interviews are conducted with urban recreational walkers/wanderers. Analysis of the data reveals participants' motivations to walk, their experience of exploratory wayfinding, as well as their use of wayfinding materials in general and GPS-enabled technology in particular. With regard to the latter, attention is paid to ways in which these wayfinding interfaces are negatively perceived. Here, it is identified that, amongst the group as a whole, the undermining of situation awareness (SA) and the negation of exploratory wayfinding practices are seen as *significant* issues. Having made this identification, an area for experimentation is framed and, within this, a design hypothesis is formulated.

Next, in the enquiry's second phase, a series of design experiments are undertaken in order to develop a *novel* wayfinding interface in response to this hypothesis. Here, an iterative development cycle leads to the design and testing of a mixed-fidelity working prototype interface through the application of qualitative and quantitative methods of data collection and analysis. By integrating and assessing the results, it is possible to assert that, for the majority of participants, SA-in-use was supported, thus verifying the hypothesis. Thereafter, the interface is presented as a *practical response* to the primary research question of the enquiry and, as such, is positioned as an artefactual contribution to knowledge. Then, through a graphic syntax analysis (Engelhardt 2002) of this artefact, a contextualised graphic syntax *for* design is generated. In setting out a series of principles, it provides

an outline for the design of a GPS-enabled WI to visually support an urban recreational walker's/wanderer's situation awareness in use and, so, may guide/inform future designs.

Further to this, in graphic syntax analysis, a reflection on the dynamic and interactive aspects of the interface leads to an extension of Engelhardt's graphic syntax framework (2002) being proposed. Here, by expanding the framework's scope, the description of the dynamic and interactive aspects of graphic representations is now made possible. It is held that this, in turn, may support the development of an expanded theory of graphic syntax.

Acknowledgements

In the first instance, I would like to offer a profound and heartfelt thanks to my supervisory team, Patricia Austin and Professor Janet McDonnell. Their unfailing guidance has enabled a tangible transformation that will remain with me.

Doctor Catherine Dixon also deserves special praise for going far beyond the call of duty. Her careful eye and attention to detail has been wonderful. Without her this would be a very different thesis; as a result, I am both thankful and indebted.

Thanks also to Doctor Rathna Ramanthan and Doctor Annegrete Mølhave who were my earliest supporters in the process. It was they who first suggested doctoral study and encouraged my progress towards application.

Further thanks must also be extended to my friends and colleagues at the Glasgow School of Art, who have, over the past number of years, provided me with an environment in which I could develop both as a researcher and lecturer. In particular, Doctor Emma Murphy, Marianne McAra, Doctor Cara Broadley, Doctor Michael Johnson and Doctor Katherine Champion have been my mainstays. Professor Donald Maclean too must be thanked for allowing me to practice my ability to form an argument, as well as introducing me to the edges of philosophy and science.

Above all, my family and friends—particularly my wife Ciara and my parents Regina and Gerard—have ensured this project reached completion. Your belief in my ability, as well as your unwavering kindness and generosity allowed me to overcome all of the difficulties I encountered. Ciara, especially, derserves credit for her understanding, empathy and patience; this has been a journey that we've taken together.

Lastly, I would like to acknowledge the support that University of the Arts London has granted me through their provision of a doctoral studentship.

Contents

Notes on Terms and Conventions

The Terms Enquiry and Thesis

Throughout this document the term *enquiry* is used interchangeably to refer, on the one hand, to the *research project* as a whole, and on the other to the *process* of conducting research. The term *thesis* is used to refer both to this *dissertation*, as well as to the *argument* that it is seen to contain.

Tone and Address

In order to aid the transferability of the research, a passive voice has been adopted in regard to description of the research process. Thus, rather than 'I', the term *the researcher* is employed in reference to the author and their actions. This is however augmented by the application of the plural *we* at key transition points in the argument, such as the introduction of a chapter's contents and the movement from one section to another. The latter approach is applied so as to evoke a shared sense of the reader and writer journeying through the text together; avoiding what might otherwise be interpreted as an austere address.

Referencing

Throughout this document the *Harvard* referencing system has been applied. Additionally, where appropriate, references for illustrations can be found in the bibliography.

Line Numbering

On pages containing text a sequence of numbers marking lines 5, 10, 15, 20, 25 and 30 is set out. This is added so as to aid the citing of particular extracts within the thesis. It should be noted that these numbers are offered to provide a measured guide, as opposed to an absolute reference. In other words they mark an ideal flow of lines rather than the specific amount of lines of text appearing on a given page. It is hoped that this will not unduly affect the reading process.

Participant Numbering

Participants are numbered sequentially according to phase of the enquiry in which they participated (i.e. either the interviews of the first phase or the design experiments of the second phase). When a particular, numbered participant is referred to a set of initials are employed in order to distinguish between phases (i.e. IP for interview participants; EP for experiment participants; see below).

List of Abbreviations

ED	exploratory design
EP	experiment participant
FS	field simulation
IP	interview participant
I-E	interface-environment
GPS	Global Positioning System
SA	situation awareness
WI	wayfinding interface
UK	United Kingdom

A Personal Statement

In June 2011, I completed a Master of the Arts in Communication Design. Here, building on an interest that I had developed in industry, 'maps' or, more accurately, cartography had become a major focus within my practice.

The completion of my degree had left me with two observations relating to this area of information design and the role of technology therein. Firstly, it appeared that while GPS-enabled devices held the potential to revolutionise maps and map-use, few truly innovative examples were apparent. Secondly and following on from the first observation, it appeared that little work—either practical or theoretical—had been done considering how novel information design approaches might support particular user experiences in particular use-contexts.

Thus, this enquiry was launched with a view to transforming these observations into viable research questions. In order to do so, it felt appropriate that practice be positioned as integral to the method, i.e. that something be made within the research process. As I set about establishing a research strategy I was confronted by the realisation that classic information design research is more or less underwritten by cognitive psychology and the lingering positivist epistemological associations this implies. Such a discovery was hugely disappointing, as it appeared to deny the possibility of a designer acting as a researcher and practice being integrated within the method.

Eventually, however, an alternative theoretical perspective (i.e. one which differed from positivism/post-positivism) was found in the philosophy of pragmatism. The adoption of pragmatism resolved multiple tensions, which might otherwise have stalled the enquiry. For example, how might one justify the generative aspects of the enquiry (i.e. that things were to be designed); how might one argue in favour of having established the truth; what was the role of theory? Responding to all such concerns, pragmatism offered a perspective, which *allowed* for practice-based research (see Section 3.1.3). This has resulted in an enquiry which is distinct from much of the research that has taken place in the field of information design. At the same time as contributing to theory, it involves design practice and seeks to speak to design practice.

However, despite the above alignment, it is important to note that my relationship to practice has undergone a significant reorientation. I began my course of doctoral study as a designer, I finish as a designer-researcher. This process of transformation is however on-going; while, I have identified areas for future research (see Section 7.8), I am fully aware that little will be achieved in isolation. As such, I now direct my efforts towards full integration within a research community. It is only in this way that my contributions may be properly disseminated and built upon.

On a final note, before proceeding to the main body, it must be pointed out that from this point on the use of the first person 'I' will be replaced by reference to 'the researcher'. Though this may seem initially austere, the aim is to direct attention away from the personality behind the research and towards the actions and decisions, which were undertaken in the course of the enquiry. Such an approach is seen to enhance the transferability of the research (see Section 3.1.4.1), i.e. the possibility of trialling the enquiry's findings in another context. However, for those interested in the 'designer's perspective', Appendix C offers a diary-based account of the process of designing the final prototype interface.

Preface
Practice-Based Enquiry as a Methodological Stance

This enquiry is seen as an example of ‘research *through* design’ (Frayling 1993:5. italics added), i.e. design practice has been *applied* in order to *conduct* research. As such, it is defined as ‘practice-based’ (Candy 2006). In selecting this methodological stance, we are in agreement with Bruce Archer (1995), who states:

> ‘There are circumstances where the best or only way to shed light on a proposition, a principle, a material or a function is to attempt to construct something, or to enact something calculated to explore, embody or test it.’
> (p.11)

Over the past two decades one of the key issues of debate surrounding practice-based enquiries has concerned the ways in which such research should be *enacted*.

Brandt and Binder (2007) suggest that research questions may lead to practical experiments, with a research programme (i.e. an overarching agenda) acting as an ‘intermediary’ between the two (p.3). In contrast, for Zimmerman and Forlizzi (2008), the process of identifying *motivations* is seen to underpin such an approach. The pair argue that design researchers tend to launch their research from within one of two motivational contexts: the ‘philosophical’ wherein concepts motivate, or the ‘grounded’ wherein a ‘real-world’ problem is tackled through the research (p.42). These motivations are then seen to allow the researcher to formulate a research question, which in turn directs the research.

IIpo Koskinen et al. (2011), offering a broader overview, propose that three different arenas of practice-based research have emerged. These are: the *lab*, the *field* and the *showroom*, which, in turn, are seen to align with three pre-established traditions: the natural sciences, the social sciences and art, respectively (p.xiii). For Koskinen et al. these traditions guide and direct the selection of particular methods.

Furthering the discussion, Ann Louise Bang et al. (2012) have recently taken issue with the above texts. In relation to Zimmerman and Forlizzi's motivational stance, they argue that the bipartite inventory of 'motivations' (i.e. philosophical or grounded) is incomplete and, in any case, often not as 'water-tight' as the pair are claiming (Bang et al. 2012:4). Responding to Koskinen et al.'s arenas (i.e. the lab, the field, and the showroom), they agree with the typologies outlined, yet find that few methods and techniques are offered. Seeking to amend this, they propose a model that is seen to act as an 'operationali[s]ation' of Koskinen et al.'s framing of design research, and relate this to Zimmerman and Forlizzi's stance on motivations. Equally, in contrast to Brandt and Binder (2007), they impose what they term a 'conscious hierarchy' upon the whole.

Thus, Bang et al. present a model wherein the design experiment is centralised; it is literally seen as a cog. Like Zimmerman and Forlizzi, a starting point is found in a motivation, or a series of motivations. From this, a *hypothesis* is formed.

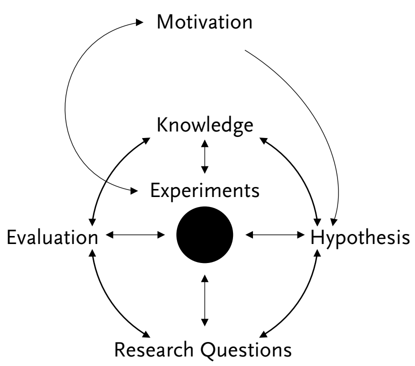


Fig. P.1 An operationalisation of research through design, adapted from Bang et. al (2012:6).

For Bang et al. it is the formulation of such a *hypothesis* that allows the design researcher to define their research question. Subsequently, both are seen as potential entrance-points from which to guide and direct design experiments as in Figure P.2 below.

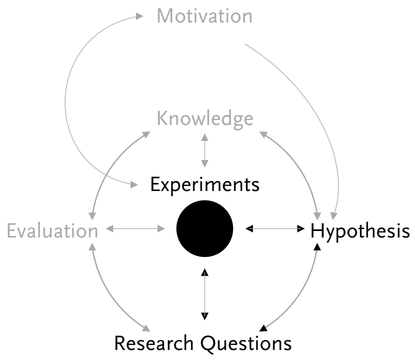


Fig. P.2 Within Bang et al.'s model (2012) both the hypothesis and/or the research question may guide and direct the subsequent research.

Once the design experiments have commenced, further experiments may be launched from any point within the cycle of hypothesis, research question, evaluation and knowledge. An ever-present link between these experiments and the motivation(s) allows for constant reflection and occasional reorientation.

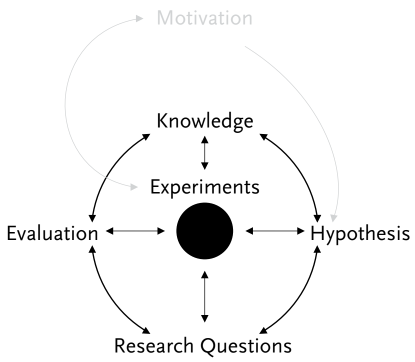


Fig. P.3 Experiments may be launched from any point along the cycle of hypothesis, research question, evaluation, and knowledge generation.

Within this research, the above model has been adapted to include two additional pre-hypothesis elements beyond the motivation: a literature review and a program of semi-structured interviews. These are positioned in a row beside the motivation. Thus all three are seen as interlinked, informing and supporting the formulation/reformulation of the hypothesis, and so deepening and enriching the initial/expanding frame of reference for the enquiry.

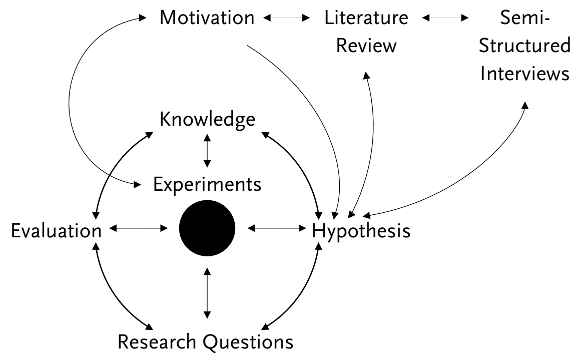


Fig. P.4 An adaption of Bang et al.'s operatisation of research through design (2012), within the present enquiry. Here, a literature review and the qualitative technique of semi-structured interview is also seen to inform the hypothesis.

The above diagram appears throughout this thesis so as to provide a simple overview of the research project. Key interactions are highlighted at appropriate points in the text, as particular words and links require emphasis. Additionally, on a number of occasions, further information is layered on top of the diagram in order to illustrate what might otherwise remain unclear within the text.

1. Introduction

This research considers the design of the GPS-enabled wayfinding interface (WI) for urban recreational walkers/wanderers. Specifically, it seeks to investigate how such interfaces can be designed to visually support an urban recreational walker's/wanderer's situation awareness (SA) as they relate to their surrounding environment in use.

The project is grounded in information design practice and theory (i.e. Engelhardt 2002; Bertin 2011/1967). Thus, a concern for the structuring of the arrangement of graphic content in graphic space is central to the research. From this, links are made to the areas of interaction design and wayfinding design, resulting in an expanded understanding of the arrangement of graphic content in graphic space in relation to its use (i.e. the user's interactions in relation to the arrangement of graphic content in graphic space) and its use-context (i.e. wayfinding as an urban recreational walker/wanderer).

The activity of urban recreational walking/wandering is here held to be a positive practice, affording a range of health benefits (e.g. NICE 2012) and allowing for particular social/environmental experiences that would otherwise remain impossible (e.g. Edensor 2000; Massey 2005; Gibson 1986/1979). Those who engage in the practice are seen to hold changeable aims and so follow indefinite routes (e.g. Solnit 2000; Benjamin 1999; Bollnow 2011/1963).

In considering the walker's/wanderer's use of GPS-enabled WIs, the enquiry draws upon phenomenological, and phenomenologically inspired, literature. That is, on work that seeks to access and describe the structuring of human experience. In this grouping we find the philosopher Edmund Husserl's later writing, the ecological psychologist James Gibson's theory of vision, and the work of anthropologist Tim Ingold. On these accounts, the person and their environment are not presented in opposition but rather seen as being co-constituted in a series of continual, on-going interactions (Gibson 1986/1979).

Leading on from the above, the view is taken that, in use, a person's relationship with their environment is ultimately shaped through the design with which they are presented.

Thus, when all is held together, this research is primarily concerned with how the structuring of the arrangement of graphic content in graphic space may shape particular forms of experience. As such, it takes the experience of information design as its primary focus.

Before moving on it is necessary to offer clarification on several points that might otherwise remain open to questioning. First, it should be noted that emphasis is placed on recreation over utility, for the simple reason that pragmatic needs (i.e. traveling from A to B) are seen as being adequately served by current examples of GPS-enabled WIS. Second, the research has been limited to an urban context due to the current limitations of handheld GPS-enabled hardware. Despite their ever-increasing accuracy and durability, mobile telephones and, to lesser extent, handheld GPS units are not yet robust enough to be relied upon while walking the mountainside or the country trail. Third and finally, it should also be noted that this research does not assume that digital technologies should replace more familiar wayfinding materials like the paper map, or fixed signage. Instead, it seeks to develop an understanding of how the arrangement of graphic content in graphic space, made possible by GPS-enabled technology, might be designed to support a particular experience within the specific use-context of urban recreational walking/wandering.

Having introduced the enquiry's concerns and focus, we will now introduce its questions, aims and objectives.

1.1 Research Questions, Aims and Objectives

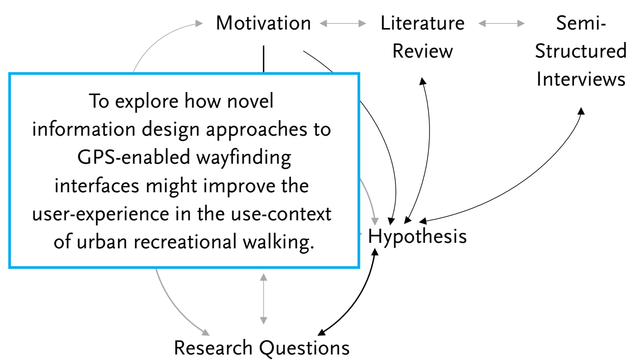


Fig. 1.1 The research questions of this enquiry are informed by general motivation (highlighted), as well as the literature review, and interview data.

Initially, the researcher was motivated to explore how novel information design approaches to WIs might better support particular user-experiences within particular use-contexts. Through a review of the literature and a programme of semi-structured interviews with walkers/wanderers, the following research questions have been formulated. How can GPS-enabled wayfinding interfaces be designed to visually support an urban recreational walker's/wanderer's situation awareness in use? From this, what are the resultant implications for information design theory and what recommendations can be made to information design practice?

1.1.1 *Aims*

The above questions have emerged from within/led to following list of aims:

- To identify how urban recreational walking/wandering is approached and practiced;
- To identify how GPS-enabled WIs are currently used and negatively perceived by urban recreational walkers/wanderers;
- Through design practice, to develop a novel WI in response;
- To define the information design features of the eventual novel WI;
- To identify implications for information design theory;
- To generate a contextualised graphic syntax for design which may guide/inform future information design practice.

1.1.2 *Objectives*

In order to meet the above aims, the following objectives were set out.

First, the literature relating to information design theory and practice, urban recreational walking/wandering and GPS-enabled WIs will be reviewed. Next, through a programme of semi-structured interviews the practice of urban recreation walking/wandering and the use of wayfinding materials therein will be investigated. In particular, attention will be paid to how these interfaces are negatively perceived by walkers/wanderers. Then, through analysis of the data, an area for experimentation will be framed and a design hypothesis formulated. From this, novel WI designs will be iteratively developed in a series of generative experiments. Thereafter, a mixed-fidelity prototype will be designed.

Through testing, the success of its interface will be assessed. Should assessment criteria be met, the design hypothesis will be verified and a contextualised graphic syntax for design will be generated. Alongside the latter process of contextualised graphic syntax generation, implications for information design theory will be identified.

From the above, we will now consider the methodological stance taken within this enquiry, i.e. practice-based research.

1.2 Practice-Based Enquiry as a Methodological Stance

The present enquiry associates with the 'research *through* design' paradigm (Frayling 1993:5, italics added). This means that design practice has been *applied* in order to *conduct* research. Thus, we may say that the enquiry is 'practice-based' (Candy 2006).

The view is here taken that such an approach results in a fundamentally different form of knowledge production, distinct from that presented by the natural sciences (Cross 2007:24). Here, action and reflection (Schön 1983) are seen to allow for the production of artefacts, which in turn may answer particular research questions (Bang et al. 2012; Binder and Brandt 2007). Further, through the trialling of such artefacts in test situations, theories *for* design (e.g. frameworks, guidelines and implications) may be generated (Zimmerman et. al 2010). Thereafter, the resultant artefacts and associated theories may be contested and debated within a research community of peers and, as such, accepted or rejected as contributions to knowledge (Keunen and Redström 2013).

Having considered practice-based research in general, we will now consider the contributions of the present enquiry.

1.3 The Contributions of the Present Enquiry

The major contributions of the present enquiry are seen as threefold.

First, an artefact—a GPS-enabled WI design, which is shown to have supported situation awareness in use (SA-in-use)—is presented. It may be seen as a *practical response* to the first research question, as set out in Section 1.1 above.

Second, a contextualised graphic syntax *for* design (Engelhardt 2002; Zimmerman et al. 2010) is also presented. In setting out a series of design principles, it provides an outline for the design of a GPS-enabled WI to visually support an urban recreational walker's/wanderer's situation awareness in use and, so, may guide/inform future designs.

Third, and finally, an extension of Engelhardt's graphic syntax framework (2002) is proposed. By expanding the framework's scope, the description of the dynamic and interactive aspects of graphic representations is now made possible. It is held that this, in turn, may support the development of an expanded theory of graphic syntax.

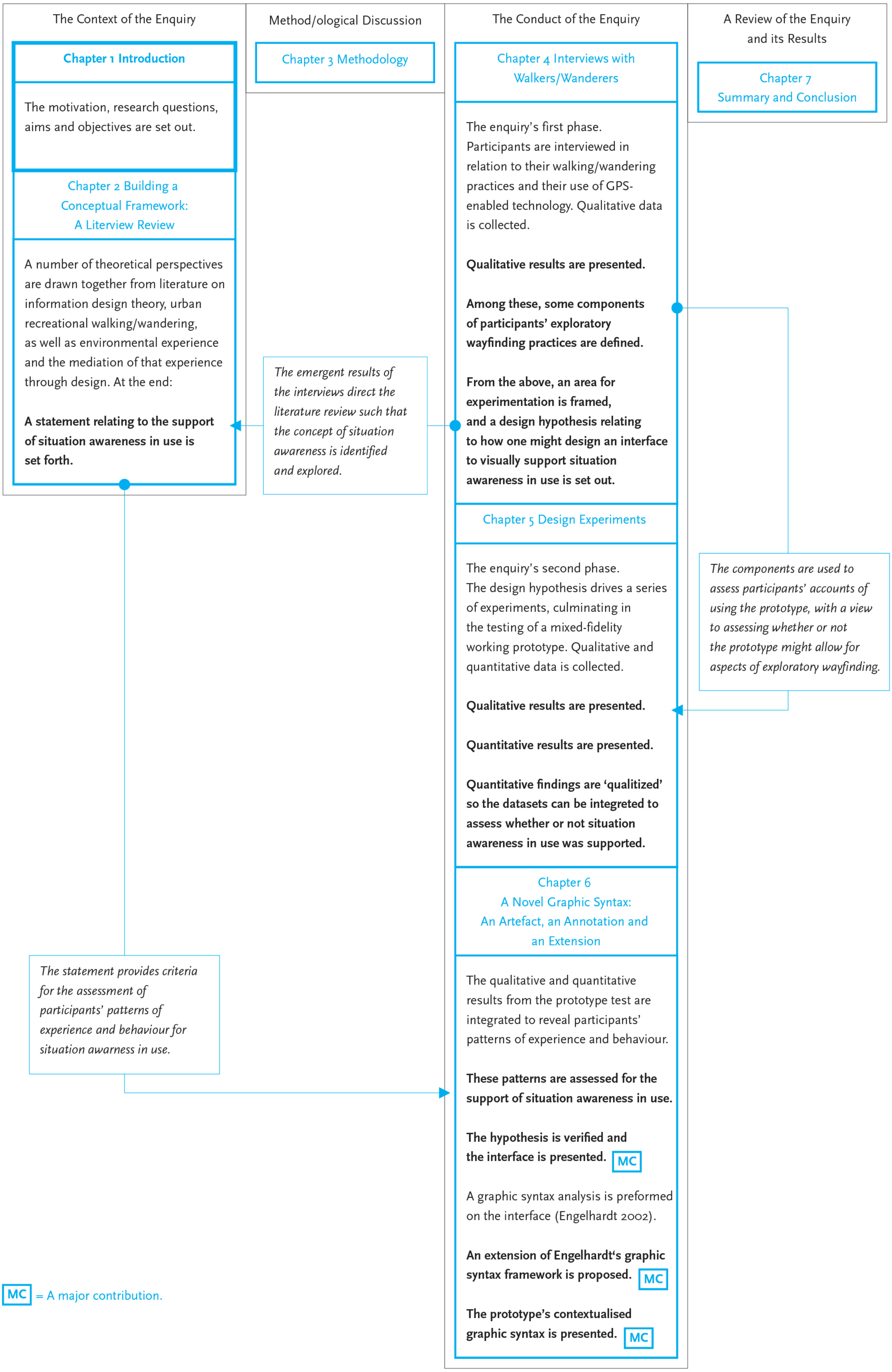
1.4 The Structure of this Thesis

This thesis contains seven chapters. The present chapter has provided an introduction to the research, as well as outlined its questions, aims, objectives, methodological stance and contributions. From here, Chapter 2 will offer a literature review. The review will position the present enquiry in relation to a number of relevant contributions and, in doing so, highlight the gaps and research directions that have been attended to. Next, Chapter 3 will provide an overview of the particular methodological stance that has been developed through the course of the enquiry, as well as detail its methods.
Then, Chapter 4 presents the results of the enquiry's first phase, wherein a programme of semi-structured interviews were undertaken and a design hypothesis formulated. From this, Chapter 5 presents the results of the enquiry's second phase, consisting of a series of design experiments culminating with a prototype test. Following directly on, in Chapter 6, the results of the prototype test are integrated and assessed. Assessment allows for the verification of the design hypothesis. Thereafter graphic syntax analysis and the generation of a contextualised graphic syntax are discussed. In between these related processes, the proposed extension of Engelhardt's graphic syntax framework is outlined. The chapter ends with the presentation of a contextualised graphic syntax for the design of a GPS-enabled WI to support urban recreational walkers'/wanderers' SA-in-use. From this, Chapter 7 finally concludes the thesis. In doing so, it provides as an overview of the enquiry, as well as its contributions and limitations, alongside setting out possible directions for future research.

Figure 1.2 below provides a map of the thesis structure as a whole, with the current chapter highlighted.

Fig. 1.2 A map of the thesis structure, highlighting the current chapter.

Map of the Thesis Structure



MC = A major contribution.

Summary

This chapter has provided an introduction to the present enquiry. Firstly, the enquiry's concerns and focus were presented. Here, it was stated that this research is primarily concerned with how the structuring of the arrangement of graphic content in graphic space may *shape* particular forms of *experience* and, as such, it takes the *experience* of information design as its primary focus. From this, the research questions, aims and objectives of the enquiry were set out. Next, referring to the specific methodological stance adopted, the enquiry was defined as 'practice-based' (Candy 2006). Thereafter, the major contributions were discussed. These were seen as threefold. The first contribution is an artefact, which may be seen to provide a *practical response* to the primary research question. The second is a contextualised graphic syntax *for* design (Engelhardt 2002; Zimmerman et al. 2010). By offering a set of principles, it provides an outline for designing a GPS-enabled WI to visually support an urban recreational walker's/wanderer's SA-in-use. The third and final major contribution is a proposed extension of Engelhardt's graphic syntax framework (2002).

2. Building a Conceptual Framework: A Literature Review

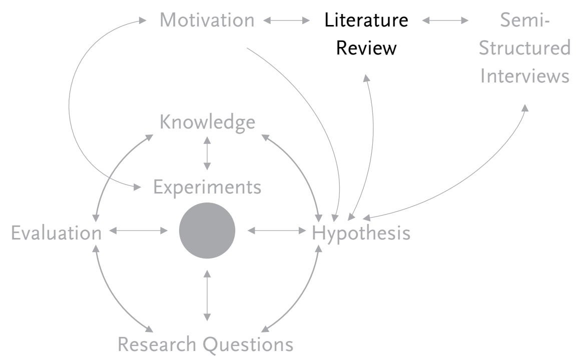


Fig. 2.1 The literature review is initially directed by general motivations and in turn informs the interview guide within the semi-structured interviews, as well as the subsequent hypothesis within the practice-based enquiry.

This chapter presents the results of this enquiry's literature review. It is divided into four sections. In the first section the field of study is identified as information design; thereafter the particular theoretical strands that have been pursued are explored. In the second section the dimensions of the activity of urban recreational walking/wandering are considered through a number of diverse bodies of literature. In the third section the structure of the relations between the walker and their environment, as well as the ways in which these relations are mediated by design and technology, are dealt with. Then in the fourth and final section, the positions which have been established through the review are collected within a visual conceptual framework. It is important to point out that much of the latter portion of the review was conducted concurrently with the programme of semi-structured interviews (see Chapter 4). Thus, the eventual position arrived at should be seen as being informed by the emergent results of analysis of this semi-structured interview data (see Sections 4.2.6 and 4.3).

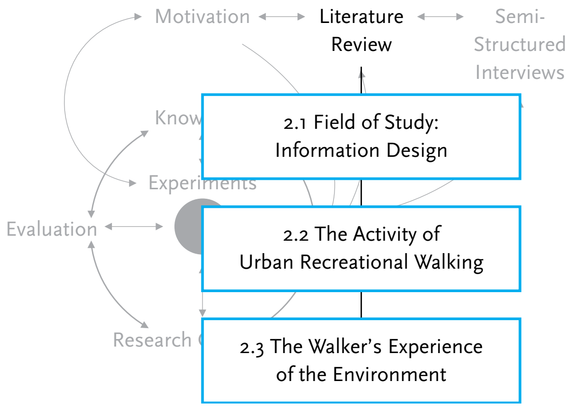


Fig. 2.2 The sections of the literature review, shown connecting to one another.

2.1 Information Design and Information Design Theory

This enquiry takes information design as its field of study. In so doing, theoretical alignment is drawn with graphic syntax theory, particularly with the work of Yuri Engelhardt (2002).

2.1.1 *The Field of Study: Information Design*

In the early 1980s, Clive Richards stated that while graphic design sought to 'amuse, delight, persuade, invigorate, provoke or otherwise stimulate', the then newly emergent practice of information design looked to 'describe, explain, inform, instruct'. (1984:1/1). Over two decades later, writing for the UK's Design Council, Sue Walker and Mark Barret claimed that information design was 'concerned with making complex information easier to understand and to use' (Walker and Barret 2005:1). More recently, commenting on the contemporary field, Jorge Frascara (2015:3) has stated that information design aims at 'the creation of effective graphic communications through the facilitation of the processes of perception, reading, comprehension, memorization and use of information presented.' Similar definitions can be found in recent texts, which broadly survey information design practice/principles, (e.g. Pettersson 2010:168; Jacobson 1999:4; Katz 2012:18; Meirelles 2013:11).

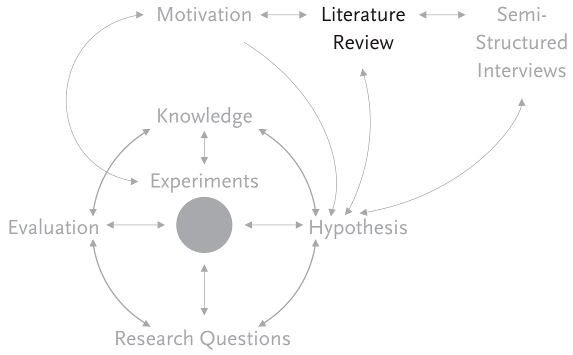


Figure 2.3 Literature Review Diagram Section 2.1

Discipline — Technological Platform — Activity

General — *Specific* — *Specific* — *General*

Information Design

2.1 Field of Study: Information Design

These texts will offer a brief introduction to the field of study: information design, as well as information design theory, and, in particular, graphic syntax theory.

Information Design Theory

Bateman, J., 2008,
Multimodality and Genre
Bertin, J., 2011/1967,
The Semiology of Graphics
Engelhardt, Y., 2002,
The Language of Graphics - a framework for the analysis of syntax and meaning in maps, charts and diagrams
Goldsmith, E., 1980,
'Comprehensibility of Illustration – an analytic model'
Horn, R., 1999,
'What is Information Design? Information Design as an Emerging Profession'
Jacobson, R., 1999,
Information Design
Kitchen, R., & Dodge, M., 2007,
'Rethinking Maps'
MacEachren, A., 1995,
How Maps Work
Perkins, C., 2008,
'Cultures of Map Use'
Richards, C., 1984,
Diagrammatics
Tufte, E., 1990,
Envisioning Information
Walker, S., 2014/2001,
Typography and Language in Everyday Life
Waller, R., 1987,
The typographic contribution to language
Ware, C., 2004,
Information, Visualisation – Perception for Design

Cognitive Psychology

Endsley, M., & Jones, D., 2012,
Designing for Situation Awareness

Wa…

…ure
…ion of design principles for urban wayfinding'
Lynch, K., 1960,
The Image of the City
Mollerup, P., 2005,
Wayshowing
Mollerup, P., 2013,
Wayshowing >Wayfinding, Basic and Interactive

Mobile Wayfinding

Brown, B., & Chalmers, M., 2003,
'Tourism and mobile technology'

Wayfinding Interface Design

Cartographic Design and Mobile HCI

Cartwright, W., Peterson, M.P., & Gartner, G., 2007,
Multimedia Cartography
Gartner, G., & Uhlirz, S., 2002,
'Catographic Concepts for realizing a Location Based UMTS Service: Vienna City Guide "Lol@"'
Elias, B., & Paelke, V., 2005,
'User centre design of landmark visualizations'
Koch, W.G., 2000,
'Jaques Bertin's theory of graphics and it's devlopment and influence on multimedia cartography'
Meng, L., 2005,
'7 Egocentres of mobile users and egocentric map design'
Reichenbacher, T., 2004,
Mobile Cartography – Adaptive Visualisation of Geographic Information on Mobile Devices

GPS-enabled Technology

General Technology

Dourish, P., 2004,
Where the Action is
Suchman, L., 2007/1987,
Human-Computer Reconfigurations, Plans and Situated Actions

Mobile Technology

McCarthy, J., & Wright, P., 2004
Technology as Experience
Willis, K., Hölscher, C., Wilbertz, G., & Li, C., 2009, 'A comparison of spatial knowledge acquisition with maps and mobile maps'

Recreational Walking

Edensor, T., 2000,
'Moving through the City'
Middleton, J., 2009,
'Stepping in time': walking, time, and space in the city'
Middleton, J., 2010,
The 'Walkable City': the dimensions of walking and overlapping walks of life'
Solnit, R., 2000,
Wanderlust: A History of Walking
Wyllie, J., 2006,
'Depths and Folds: on Landscape and the Gazing Subject'

Human-Spatial Interaction

Human Geography

Massey, D., 2005,
For Space

Anthropology

Ingold, T., 2000,
The Perception of the Environment

Sociology

deCerteau, M., 1984,
The Practice of Everyday Life
Urry, J., 2007,
Mobilities

Ecological Pyschology

Gibson, J., 1986,
The Ecological Approach to Visual Perception

Cultural Studies / History

Bagwell, P., 1974,
The Transport Revolution
Benjamin, W., 1999,
The Arcades Project

Literary Criticism

Wallace, A., 1993,
Walking, Literature and English Culture

Philosophies of Embodiment and Place

Bollnow, O., 2011/1963,
Human Space
Casey, E., 1997,
The Fate of Place
Husserl, E., 1981/1932,
'The World of the Living Present and the Constitution of the Surrounding World to the Organism'
Ihde, D., 1990,
Technology and the Lifeworld
Ihde, D., 2009,
Postphenomenology and Technoscience

Further to these, offering a global perspective through the approval of general assemblies, the International Institute of Information Design currently defines information design as:

> 'the defining of the requirements governing the selecting, rendering, and transmission of information for the purpose of knowledge transfer as well as the optimization of the information with respect to these requirements.'
> (International Institute of Information Design 2014:10)

While recognising the value of all such contributions and (based on its source) the primacy of the latter definition, this thesis offers a somewhat shorter definition, which more immediately reflects the particular approach that has been pursued in this research. Thus, within this thesis, information design is defined as

> the practice of systematically developing and arranging graphic content within a graphic space to produce graphic representations for particular platforms or environments, such that the needs of a given audience are met.

Examples of such graphic representations are diagrams, maps, books, signage, and interface designs (Jacobson 1999; Waller 2011/1995). As a whole, information design is seen as a multi-disciplinary practice; wherein separate communities of practitioners work to design particular graphic representations for particular platforms. Those working in these areas might choose to call themselves graphic designers, cartographers, book designers, wayfinding designers or user interface (UI) designers. There is, however, a community of practitioners and researchers who identify directly with information design practice, and so call themselves information designers (Waller 2011/1995:2).

In seeking to articulate a history of information design practice many have turned to the visual/material outputs of ancient societies or indigenous cultures. For example, Horn (1999:15) refers to Egyptian market-place scribes being involved in the 'business of assisting others to make their communications more effective'. Similarly, Owens (2008:66) notes Greenlander's tradition of carving tactile wooden representations of the coastline and highlights the complexity and versatility of these objects as navigation aids. Others, focusing on more formal approaches, locate information design's origins in the early modern era. In this vein, Tufte (1990) weaves together an eclectic series of examples including Galileo's highly illustrative notation style, early scientific diagrams, and nineteenth-century railway timetables.

While these narratives all trace information design practice through many centuries and cultures, the academic study of information design practice is a relatively recent development. Stiff (2005) traces its origins to a series of conferences and meetings that took place in the mid-to-late 1970s (p.224). In so doing, he places particular emphasis on the 1978 Nato conference on 'the visual perception of information' held at Het Vennobos (p.218). The conference proceedings led to the eventual publication of Easterby and Zwaga's *Information Design: the design and evaluation of signs and printed material* (1984), seen as a seminal information design text. In 1994, a subsequent, related symposium on 'public graphics' held at Lunteren, led to the publication of Zwaga, Boersema and Hoonhout's *Visual Information for Everyday Use: Design and Research Perspectives* (1999). This text reflects on the continuing maturation of the discipline, discussing its methods, as well as the design approaches taken in areas such as: instructions, warnings, forms, tables, maps, wayfinding materials, and graphic symbols.

Other, separate conferences have also resulted in the publication of similarly significant information design texts. Penman and Sless's *Designing Information for People* (1992) offers the proceedings of the first Australian symposium on information design of the same year. While Spinillo and Coutinho's *Selected Readings in Information Design* (2004) collects contributions from the *Information Design International Conference* held in 2003 in Recife, Brazil. In addition to these, though not associated with a conference, Jorge Frascara's recent *Information design as principled action: Making information accessible, relevant, understandable, and usable* (2015) draws together an extensive list of researchers and practitioners to offer a broad ranging survey of the contemporary field.

Beyond these texts, over the last three decades a number of centres, exclusively concerned with pursuing information design research agendas, have been established. Most prominent among these is the University of Reading's Centre for Information Design Research as well as its Simplification Centre, both of which are associated with the university's Department of Typography and Graphic Communication. Also prolific is the Communication Research Institute, founded in 1985 in Melbourne and led by David Sless.

It terms of discourse, a number of academic journals are seen to serve the field. Most directly, the *Information Design Journal* (IDJ) has provided a continuous forum for discussion across the otherwise bounded areas of visual communication, psychology, linguistics and human-computer interaction. Another relevant title is Visible Language, a journal broadly concerned with visual communication research. Beyond these, published work pertinent to information design practice, theory and history, can be found in journals such as *Cartographia*, *The Design Journal*, *Baseline* and *The Information Society Journal*, among others.

Having considered information design practice and its academic study, we will now turn to information design theory.

2.1.2 *Information Design Theory*

In broad terms, theory pertaining to information design may be seen to focus on the structure of information design outputs, as well as the processes of production and use associated with these outputs. Alongside information design researchers, contributions have been made by those operating in the fields of psychology, cartography and computer science. Key areas of study include typographic structures (e.g. Waller 1980, 1987; Walker 1982, 2014/2001; Twyman 1982), document and book design (e.g. Bateman 2008; Schriver 1997; Waller 1987; Norrish 1987; Gillieson 2008; Walker 2012), as well as the visual arrangement of graphic representations such as maps, diagrams, and charts (e.g. Bertin 2011/1967; Richards 1984; Twyman 1979; Horn 1998; Engelhardt 2002). The methods of information design have also received considerable attention (e.g. Fisher and Sless 1990; Penman and Sless 1992; Frascara 2015; Adams 1999).

With regard to the study of typographic structures, work has been done: considering the typographic contribution to language (Waller 1980; 1987); developing descriptive frameworks, which might be applied to the visual organization of verbal graphic forms regardless of the mode of production (Walker 1982; Twyman 1982); and investigating the practices and prescriptions relating to ordinary language typography (Walker 2014/2001).

Rob Waller's contribution here, specifically his Ph.D. thesis (1987), is seen as particularly significant. In the thesis, Waller outlines an approach to the analysis of typographic form through the articulation of a number of 'structures', which consider the writer-text-reader relationships set alongside the concept of typographic genres.

Three writer-reader-text structures are proposed. These include: topic, referring to the structures that express the intentions of the author through the design (p.194); artifact, referring to the physical attributes of the text as constrained by medium, format and technology; and access, referring to the reader's needs, abilities and expectations in relation the document (p.234). The final structure, relating to the notion of typographic genres, looks at how everyday formats such as 'leaflets', 'magazines' and 'books' may be seen to be comprised of various combinations of the topic, artefact and access structures (p.298).

Leading on from the above, in terms of document design, the work of Karen Schriver and John Bateman is worth highlighting. Schriver (1997) presents a valuable and comprehensive overview of information design research in the area. Her basic argument is that designers need to engage more fully with document users, working to better understand their activities and requirements. Bateman, along with others, has investigated the potential of analysing the presentation of information across combinations of multiple visual modes (i.e. text and images) and formats in document design (e.g. Bateman 2008, Delin, Bateman and Allen 2002). Informed by Waller's work, Bateman's framework looks at how such 'multimodality' in written documents can be analysed and accounted for. From this basis it considers how documents can be seen as meaningful, i.e. be seen as rhetorical. Finally, it is proposed that through a recognition of reoccurring properties, document genres can be identified. Building on this work, Waller and Delin have proposed that the framework might be positioned as a foundation from which information design patterns could be developed (2010).

The next theoretical grouping, i.e. theorists concerned with the visual arrangement of graphic representations, have to varying degrees been informed by the semiotic tradition, i.e. the systematic study of signs. Here, some contributors offer descriptive frameworks, which allow for the layered analysis of outputs (e.g. Twyman 1979; Richards 1984; Engelhardt 2002), others also offer frameworks but augment these with sets of principles and rules (e.g. Bertin 2011/1967; Horn 1998).

In relation to the methods of information design, David Sless's work is particularly noteworthy. Through a sustained research programme undertaken with colleagues at the Communication Research Institute, Sless has developed a well-defined overview of an information design method, which has been shown to produce effective results. The method is based on the concept of a loop and incorporates seven stages moving from scoping, baseline measurement and prototyping through to iterative testing and implementation. The loop is completed through the monitoring of the project outcome (see Sless 1992; 2008).

Beyond the above, the field of cognitive psychology may also be seen to link to information design theory, in particular through the study of the relation of visual perception to cognitive function. As is to be expected in this domain, emphasis is placed on the cognitive aspects of use. Thus, the abstract concepts of knowledge, memory, attention, learning and problem solving are seen to underpin and define information design use (e.g. Ware 2004; MacEachren 1995). There are a number of researchers who directly associate their work with the field of information design. Among these, Patricia Wright has been particularly active, undertaking extensive work relating to the design and use of tables, guidelines and instructions (e.g. Wright 1999, 1980; Wright et al. 1982). Similarly, the work of Dyson, looking at screen typography (e.g. Dyson 2005, 2004; Dyson and Suen 2016) and Black, looking at information use (e.g. Black et al. 2013; Black and Stanbridge 2012; Black and Rayner 1992), has also been approached from a psychological perspective.

As the present enquiry is practice-based and concerned with the design of a particular form of graphic representation (i.e. a GPS-enabled wayfinding interface), as opposed to a text-based document, it aligns with those who have considered the visual arrangement of graphic representations such as maps, diagrams, and charts. That is, the theoretical grouping is seen to link to the semiotic tradition (i.e. Bertin 2011/1967; Richards 1984; Engelhardt 2002). On the one hand, this alignment allows for the systematic and precise description of the arrangement of graphic content in graphic space, such that the comparison and transferability (see Section 3.1.4.1) of graphic representations is enabled. On the other, the semiotic approach is also seen to allow for the study of the viewer's/user's holistic experience of a graphic representation, as opposed to directing focus towards one or another abstract concept that may underpin that experience (e.g. memory).

Thus, we shall first turn to the work of Jacques Bertin, whose theory of graphics as a sign-system is still upheld as a key framework from which a set of visual information design principles may be obtained (e.g. Koch 2000; MacEachren 1995).

2.1.3 *Bertin's Semiology of Graphics*

In *The Semiology of Graphics* (2011/1967), Bertin sets out a detailed, illustrated guide to his theory of graphics as a sign system. In the book's first part, alongside an outline of his proposed approach to information analysis, Bertin offers the reader an overview of what are said to be the *properties* and *rules* of the graphic sign system[1].

With regard to the properties, we are told that graphic representations may be understood as being defined by an x-y plane (i.e. a delimited space) and, within this, are seen to contain a set of graphic 'marks'. The positioning of graphic marks on the plane is seen to depend on, what is referred to as the plane's *level of organisation* (p.8). According to Bertin, the organisation of marks may be *selective* (i.e. the marks are seen as different), *associative* (i.e. the marks are seen as related), *ordered* (i.e. the marks are shown in a sequence) or *quantitative* (i.e. dependent on numerical values established within the plane) (p.49). Further to the above, the graphic marks themselves may be varied through the alternation of the 'visual variables', which are listed as being: size, value (i.e. brightness), texture, colour, orientation and shape (p.40).

With regard to the *rules* of the graphic system, Bertin differentiates between diagrams, networks and maps. For each, a series of rules of construction are offered (pp.171-174). Further, across all formats, a set of rules of legibility are provided (pp.175-189). These latter rules are concerned with graphic density (i.e. the amount of information presented), angular legibility (i.e. meaningful perceptible differences made possible by the dimensions of the graphic plane), and retinal legibility (i.e. meaningful perceptible differences between associated graphic marks).

Though Bertin's graphic sign-system is seen to offer potential as a framework to describe the arrangement of graphic content in a graphic space, it is also found to be lacking. Here, the view is taken that though we are afforded a set of concepts outlining 'graphic properties' (e.g. the plane, graphic marks and visual variables), the extent to which the arrangement of these can be described is limited. In particular, there is no means by which the relationship between two graphic marks can be described in meaningful terms, other than through the level of organisation applied on the 'plane' (i.e. the space of the representation). Thus, graphic marks can be said to show a selective, associative, ordered or quantitative level of organisation; but there are no comparable set of terms by which their inter-dependent structural relations may be described. For example, there is no means by which we may say that two graphic marks are 'linked', or that one is 'contained' by another. This is seen to limit any attempt at description.

More recently, Bertin set out what he termed his 'matrix theory of graphics' (2011/2004:415-434). This theory is seen to go some way to addressing the particular shortcoming identified above by offering a list of prototypic terms by which the relations between individual/groupings of graphic marks may be described. The list includes such terms as pattern, proximity, links and so on (p.421). However, regrettably, the list of terms are offered without any definitions attached. As such, they lack clarity and, so, are seen as unsatisfactory.

Thus, in seeking a framework that *would* allow for such descriptions of the arrangement of graphic content in graphic space, it is necessary to expand our frame of reference. Here, we turn to other semiotically-informed information design theories.

2.1.4 *Semiotically Informed Theories*

Beyond Bertin, a number of theorists have sought to frame proposals which might be applied in the description of the arrangement of graphic content in graphic space. Michael Twyman (1979) sets out a 'schema for the structure of graphic language'. Herein emphasis is placed on the modes of configuring and modes of signifying. Combinations of alternative approaches to each are identified in a matrix (p.120). While Twyman's proposal is compelling, he acknowledges outright that it does not arise out of a 'programme of sustained research' and is not yet fully resolved (p.118).

Another contribution is made by Robert Horn (1998). In *Visual Language: Global Communication for the 21st Century*, Horn sets out a theory premised on the notion that approaches to arranging graphic content may be seen as an emergent international language. Pursing this concept, it is proposed that graphic content may be seen to divide into one of three possible types of 'morphological elements of visual language': an image, a shape or a word (pp.7-8). Interestingly, Horn goes on to suggest that one may identify typologies or 'syntactical structures' arising from the arrangement of such elements. Here, the concepts of 'proximity grouping', 'network', 'boundary', 'concentric' (referring to radical arrangements), 'level' (referring to the separation of elements), and 'matrix' are proposed (pp.81-82).

While Horn's proposed theory allows for the explicit description of relationships among elements (an advantage over Bertin), his treatment is found to be lacking. In particular, we are offered many images but little by way of explicit demonstration of how the theory might be applied in analysis. Further, though a broad-ranging study is offered, it appears that little effort has been made to situate the work within contemporary discourse on the subject[2] (i.e. discourse relating to the arrangement of graphic content in graphic space).

Thus, looking beyond the above, this enquiry identifies three key semiotically-informed information design theorists who offer robust frameworks for analysing graphic content: Evelyn Goldsmith (1978), Clive Richards (1984), and Yuri Engelhardt (2002). We will now briefly consider the contribution of each.

Evelyn Goldsmith's *An analysis of the elements affecting comprehensibility of illustrations intended as supportive to text* (1978) is often citied as a foundational example of a framework that attempts to approach graphic representations from the perspective of Charles W. Morris' semiotics (1938), wherein language structures are studied. In developing her framework, Goldsmith adapted the work of Morris in such a way as to allow for the analysis of what she termed 'unities' within illustrations. Unities refer to areas of an illustration that can be taken as a *separate, discrete* element (1980:205), either structurally or meaningfully.

Thus, from Morris, analysis may occur on three levels: the *syntactic*, the *semantic* and the *pragmatic*. The *syntactic* level, the most basic of the three, refers to how graphic representations may be seen to present recognisable patterns that can be understood as images of objects. The *semantic* level refers to the relationship between 'what is shown and what is meant' by the graphic, i.e. what the images of objects may be taken to *mean*. Finally, the *pragmatic*, refers to how the reader's social, cultural and local context affects the interpretation of the graphic (Goldsmith 1980:204-205). In other words, what the image means *to someone*. Of the above, the syntactic level would allow for the description of the relations between various marks in an illustration but, again, as no set of terms are offered any attempt at *systematic* description would be limited.

Clive Richards's Ph.D. thesis (1984) on the structuring of diagrams was partly inspired by Goldsmith's framework, as well as Twyman's earlier proposals (1979). Richards also presents a three-level analytic framework, though he adapts the original terms such that levels become 'modes'. Thus, on his account, diagrams may be thought of as containing:

- Modes of Organisation (analogous to the syntactic level);
- Modes of Depiction (analogous to the semantic level);
- Modes of Correspondence (analogous to the pragmatic level).

(Richards 1984:3/32)

These modes can be taken as lenses through which a diagram's *significant elements* (in Bertin's terms the diagram's 'graphic marks') can be studied. As with Goldsmith's syntactic level, Richards's modes of organisation would technically allow for a description of the relations between various elements in the diagrams. In this vein, Richards proposes that diagrams may be constructed through instances of:

- variation;
- linking;
- grouping.

(ibid:8/4)

Variation is analogous to Bertin's concepts of ordered or quantitative levels of organisation (see Section 2.1.3), i.e. that elements may be shown in *sequence* or are positioned according to a representation's *numerical values*, respectively. *Linking* refers to instances wherein element-to-element relations occur such that these elements may be seen to connect to one another. *Grouping*, finally, refers to instances wherein elements are seen in association with one another.

By offering the above concepts of *linking* and *grouping*, Richards's framework extends beyond the descriptive possibilities of Bertin. However, it remains, fundamentally, a model for studying diagrams rather than graphic representations more generally. At a conceptual level, this focus on diagrams is seen to compromise its applicability within the present enquiry.

Thus, while both Goldsmith's and Richards's models may offer value within their prescribed areas of application (i.e. *illustrations* and *diagrams* respectively), neither is seen to present a descriptive framework that might allow for the systematic, precise description of GPS-enabled wayfinding interfaces (WIS).

In seeking such a framework, the work of Yuri Engelhardt (2002) has been selected on the basis that it provides a suitably flexible and wide-ranging descriptive framework allowing for the *systematic, precise description* of graphic representations such that they may be discussed in detail, thus enabling direct comparison and transferability (see Section 3.1.4.1). Engelhardt's theory is set out in his Ph.D. thesis (2002), which argues in favour of conceiving of a *language of graphics*.

2.1.5 *Engelhardt's Language of Graphics*

Engelhardt's thesis, *The Language of Graphics* (2002), aims to 'explore the *general principles of visual languages*' (p.4, italics in original) that can be said to hold across all cultures. In seeking to meet this aim, it sets forth what is claimed to be a unifying theory, which when taken as a framework allows for the analysis of 'the full spectrum' of graphic representations, including maps, charts and diagrams (p.7). Its emphasis is on the syntactic and the semantic, i.e. on the *arrangement and meaning* of a graphic.

Taking inspiration from Noam Chomsky's recursive conceptualisation of language, Engelhardt proposes that graphic representations can be *recursively* decomposed (p.13). In such a decomposition, a 'graphic representation' is seen as a 'graphic object'. A graphic object, in turn, may be an 'elementary graphic object' (analogous to Bertin's 'graphic mark' (see Section 2.1.3) or

> 'a composite graphic object, consisting of:
>
> - a graphic space that is occupied by it, and
> - a set of graphic objects, which are contained within that graphic space, and
> - a set of graphic relations in which these graphic objects are involved.'
>
> (Engelhardt 2002:14)

Additionally, graphic objects are also seen to contain 'meaningful graphic *properties*' (Engelhardt 2006:105, italics in original). These properties are, for the most part, analogous with Bertin's visual variables (e.g. size, shape, colour; see Section 2.1.3).

Further to the above, taking guidance from the linguistic notion of the 'compositionality of meaning', Engelhardt argues that alongside decomposing a graphic object's structure, it is possible to *interpret* various aspects of the structure. Here, in interpretation one considers: the types of correspondence (i.e. the relationship between what is shown and what is meant); its modes of expression (i.e. whether objects are pictorial or non-pictorial); the informational role of graphic objects; and the type of information represented. Then, beyond this, Engelhardt also suggests that graphic representations may be *classified* as particular *types* of representation. Gathering the whole together, he lastly recommends that in seeking to apply the framework, focus be directed to the following three areas:

- The syntax of the spatial structure;
- The types of correspondence;
- The type of graphic representation.

In order to gain a fuller understanding of the framework, we now consider its various facets in some detail, beginning with the core concept of the syntactic structure.

2.1.5.1 *The Syntactic Structure of a Graphic Representation*

For Engelhardt, the syntactic structure of a composite graphic object (i.e. a graphic object that is recursively seen to contain other graphic objects) refers to the set of graphic relations 'in which the graphic objects are involved' (ibid:30). This involvement is seen to be based on the notion of *anchoring*, wherein an object is anchored either to its position within the graphic space and/or to other graphic objects (ibid:55). The type of relations which result may take several forms, as set out in figure 2.4 below.

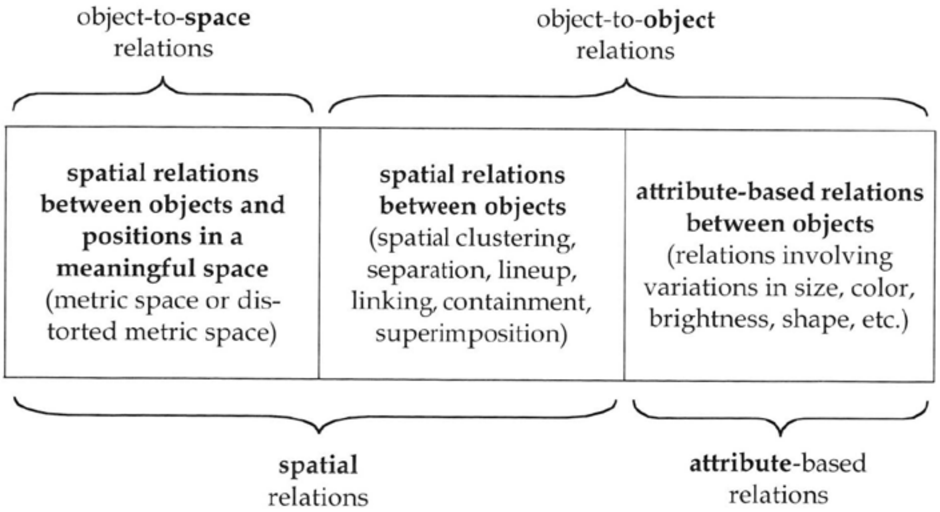


Fig. 2.4 Engelhardt's overview of syntactic structures, showing the distinction between object-to-space relations and object-to-object relations along the top (2002:30).

As may be noted above, a distinction is made between those relations which are understood as 'spatial' and those relations which are said to be 'attribute-based' (i.e. relating to aspects such as size, colour and shape). A further distinction is made between object-to-space relations and object-to-object relations. While object-to-space relations may *only* be *spatial*, object-to-object relations may be either spatial or attribute-based.

In order to provide an overview of both of these sets of relations (i.e. object-to-space and object-to-object relations) we will turn first to object-to-space relations.

Object-to-space relations, as may be apparent, refer to the relationships which occur between graphic objects and the graphic space in which they are positioned. Within this set of relations, Engelhardt proposes several categories of syntactic structure, which may include 'metric space', 'distorted metric space', and 'composite metric space'. The below table sets out a definition for each category.

Object-to-Space Relations

Type of Object-to-Space Relation	Description
Metric Space	A graphic space with a single metric axis (e.g. a timeline) or an integral metric space, wherein all 'geometric properties of Euclidian space are subject to interpretation' (e.g. a topographic map) (p.57).
Distorted Metric Space	A graphic space which, in representing information, preserves a sense of physical order and approximate direction, but not the ratio of distance (p.65).
Composite Metric Space	A graphic space which combines two or more basic metric spaces (e.g. a two axis chart) (p.57).

Table 2.1 Types of object-to-space relations and their descriptions.

Moving on to object-to-object relations, we turn first to *spatial* object-to-object relations. Here, Engelhardt proposes the following categories of syntactic structure: spatial clustering, separation, lineup, linking, containment and superimposition. The below table sets out a description of each.

Spatial Object-to-Object Relations

Type of Spatial Object-to-Object Relation	Description
Spatial Clustering	'The spatial arrangement of a set of graphic objects into two or more groups' (p.32).
Separation	The division of graphic objects (p.34).
Line Up	The arranging of graphic objects in a 'string' (p.36), e.g. numbers around a clock face.
Linking	The relating of one graphic object to another based on the imposition of a triangle, a band or a line (p.40), e.g. the letters A and B being linked by a triangle.
Containment	The surrounding of one or more graphic object(s) by another larger graphic object (p.44), e.g. a boundary line containing a city dot.
Superimposition	The foregrounding of one graphic object on top of another (p.50), e.g. the compass rose on a map.

Table 2.2 Types of spatial object-to-object relations and their descriptions.

As was noted above, also included for consideration within object-to-object relations are *attribute-based* relations. Attending to these, Engelhardt helpfully distinguishes between those attributes which may be defined as *spatial* and those which we may consider *area fill*. Spatial attributes are those which are seen to *affect* the *anchoring* of a graphic object in graphic space (i.e. size, shape, orientation, and position). Area fill attributes are those which do *not* affect this anchoring of the graphic object in graphic space (i.e. colour, value, grain).

Further to the above, Engelhardt also discusses the ways in which both object-to-space and object-to-object relations may express information. With object-to-space relations the following may be expressed:

- Order;
- Proportion;
- Direction.

Then, object-to-object relations may express:

- Association;
- Disassociation;
- Order.

(Engelhardt 2002:55)

Leading on from his discussion of syntactic structures, Engelhardt next introduces the possibility of what he terms *syntactic roles* emerging from within a set of graphic relations. We will now briefly turn to look at these.

2.1.5.1.1 *Syntactic Roles*

The syntactic roles of graphic objects are seen to result from their *anchoring* within the syntactic structure (Engelhardt 2002:74). Such anchoring may result from the object's meaningful positioning in graphic space or in relation to other graphic objects. Thus, we may see object-to-space anchoring and/or object-to-object anchoring. By way of a useful example, let us take the object-to-object anchoring of 'linking', which is defined as:

> 'a basic type of object-to-object relation that involves graphic objects with two syntactic *roles*: *nodes* and *connectors*. A connector is a graphic object in the shape of a triangle, band or line that is *anchored* to two other graphic objects (nodes), connecting them.'
>
> (2002:40, italics added)

To furnish this example, we may imagine two circles (i.e. nodes) being *linked* by a pointing triangle (i.e. a connector). Thus, one circle is seen to *lead on* to the other and, so, a *syntactic role* emerges.

Other commonly recognisable examples of two separate graphic objects playing syntactic roles are *labels* and *containers*. A label can be piece of text, which is seen as being *anchored to* another graphic object (e.g. a city's name appearing above a circle on a geographic map) (p.34). A container is a graphic object, which is seen to surround another graphic object (e.g. a boundary line enclosing a circle) (p.44).

The above examples provide us with an insight into how syntactic roles may emerge from within object-to-object anchorings; but there are also many examples of object-to-space anchorings. With object-to-space anchorings, the syntactic role is designated by the *meaningful* position that the graphic object is seen to occupy within the graphic space. Here, we are presented with, what Engelhardt refers to as, a *locator*. A locator is a graphic object, which is seen to *locate* the position of a particular object within a graphic representation (e.g. a circle *locating* the position of a city). Subsets of the locator category include *point locators*, *line locators* and *surface locators*, which locate the *position* of points, the *path* of a line, and the *area* of a surface, respectively (pp.75-76).

The above provides us with a sufficient overview of Engelhardt's concept of syntactic structures, we will now move on to consider some of his proposals regarding the interpretation of graphic representations.

2.1.5.2 *The Interpretation of Graphic Representations*

For Engelhardt, the semantic analysis of the meaning of a graphic representation is seen to parallel analysis of its syntactic structure (2002:16; see Section 2.1.5.1). In the order to aid the process of interpretation, Engelhardt endeavours to offer 'a systematic and consistent approach' (p.96). In this, it is suggested that we may consider a graphic representation's types of correspondence, its modes of expression, the informational roles of graphic objects and the type of information represented. Here, types of correspondence and modes of expression are seen as key to the theory and its application as an analytic framework. Thus, we shall look at each in turn, beginning with types of correspondence.

Types of correspondence refers to the relationship between 'what *shown* and what is *meant*' (p.97, italics in the original). Correspondence can be seen to occur at the level of the *spatial structure*, the level of *elementary graphic objects*, and the level of the *visual attributes* displayed by those graphic objects. Three main types of correspondence are proposed: *literal*, *metaphoric*, and *arbitrary-conventional*[3]. On the below table, these types are defined and thereafter an example for each of the various levels is offered. (It should be noted that these latter examples are derived directly from Engelhardt 2002:100).

Types of Correspondence

Type of Correspondence	Definition	Elementary Graphic Object Example	Visual Attribute Example	Spatial Structure Example
Literal	'[W]hat is shown is based on similarity to the physical object or structure that is meant…' (Engelhardt 2002:99)	A 'wine glass' icon standing for a 'wine glass'.	A yellow desert and a green forest on a map.	The arrangement of locations on a map. The connections on a wiring diagram.
Metaphoric	'[B]ased on a (supposed) analogy between what is shown and what is meant…' (Engelhardt 2002:99).	A 'wine glass' icon standing for 'fragile'.	The relative size of bars on a bar chart.	The arrangements on a x-y chart. The connections in a family tree.
Arbitrary-Conventional	'[W]hat is shown seems to stand for what is meant by pure convention…' (Engelhardt 2002:99)	An 'elephant' icon standing for the Republican Party.	Colour coding of electrical wires.	The arrangement of red traffic lights appearing above green traffic lights.

Table 2.3 A definition of each type of correspondence, as well as an example for each of the levels at which it may be identified.

In regard to our present concern, i.e. the design of GPS-enabled WIS, attention must be drawn to two particular aspects of correspondence at the level of the *spatial structure*.

First, when discussing *literal correspondence* with regard to the representation of a 'physical' structure (as in a map), Engelhardt contrasts this with the notion that wholly conceptual structures may also be represented. Here, he goes on to state that the spatial structures of graphic representations may be divided into three different groups, depending on their 'literalness'. These are as follows:

- Spatial structures that represent physical structures, as found in maps and pictorial diagrams;
- Spatial structures that represent conceptual structures, which rely on a

metaphoric correspondence. Here, the structuring of a family tree acts as a key example;

- Spatial structures that represent hybrid structures, involving both literal and metaphoric correspondence. By way of example, one might imagine a map wherein quantitative statistical information determines one or more of the dimensions. Engelhardt suggests that the below image (figure 2.5) may be seen to exhibit a hybrid spatial structure.

(Engelhardt 2002:103-104)

FIGURE 2-30: U.S. population density. SOURCE: By Agnew Moyer Smith 2000, http://www.understandingusa.com

COMMENT: Note that both this and the previous figure show spaces that are *hybrids* of *physical* space and *conceptual* space. In this case we have a combination of *horizontal* physical space with *vertical* conceptual space. In the previous figure this is the other way around.

SYNTAX OF SPATIAL STRUCTURE (2.5): A *surface locator* (the whole landscape) in a three-dimensional *composite metric space*, with *labels* (the textual comments) that are attached by *connectors*. Embedded in the surface locator are *line locators* (marking State borders) and very tiny *point locators* with *labels* (marking cities). The composite space is constructed through *simultaneous combination* of a two-dimensional horizontal *integral metric space* and a *vertical metric axis*.

TYPE OF CORRESPONDENCE (3.1): SPATIAL STRUCTURE: The horizontal integral metric space involves *literal* correspondence (physical arrangement on the map stands for physical arrangement in the world), while the vertical metric axis involves *metaphoric* correspondence (height metaphorically stands for population density).

TYPE OF GRAPHIC REPRESENTATION (4): A *statistical map* (= both a *map* and a *statistical chart*).

Fig. 2.5 An example of a hybrid spatial structure, where both literal and metaphoric correspondence may be identified (Engelhardt 2002:64).

The second pertinent aspect of spatial structure correspondence that we must pay attention to when considering the design of GPS-enabled WIS, relates to arbitrary-conventional correspondence. Discussing this, Engelhardt states that this type of correspondence may involve either:

- External convention, which is established outside the representation (e.g. maps are orientated towards the north);

- Internal convention, which is not established by convention but instead is seen to emerge within the graphic representation and is 'usually explained by some kind of *legend*'.

  (Engelhardt 2002:111, italics in original)

Having thereby covered types of correspondence, we now turn to modes of expression. Here, Engelhardt offers two possible modes of expression for an elementary graphic object: such objects may be seen as either *pictorial* or *non-pictorial*. Pictorial objects are said to range from realistic to schematic (i.e. highly abstract). Non-pictorial objects, on the other hand, are simply defined as abstract shapes (e.g. circles and triangles), text (e.g. words), and numbers (p.119).

Thus, we have given consideration to two key aspects of the interpretation of graphic representations (i.e. types of correspondence and modes of expression). We will now look at the final area of Engelhardt's theory: his classification of types of graphic representation.

2.1.5.3 *Types of Graphic Representation*

At the end of his thesis, Engelhardt offers a list of what he believes to be the 'commonly distinguished' types of graphic representation. These are split into *primary* types (i.e. those which might be characterised as elementary types) and *hybrid* types (i.e. combinations of the elementary types). The ten primary types are listed as: 'map, picture, chart, time chart, link diagram, grouping diagram, table, (composite) symbol, written text…' (2002:137). The hybrid types combine aspects of the above. Thus we are offered such types as 'statistical time charts' and 'chronological link diagrams'.

Within this system, classification of the graphic representation is said to be based on the syntactic structures observed in the object-to-space and object-to-object relations of the representation (see Section 2.1.5.1), as well as the type of information expressed therein (p.137).

Classification is seen as the last stage in the analytic process. Consequently we are now in a position to present a diagrammatic overview of all that has been covered above. It will be noted that the content is divided between that which is *syntactic* and that which is seen as *semantic* (i.e. based on interpretation). Additionally, the analytic path, i.e. the recommended approach to the conduct of analysis, is highlighted in blue.

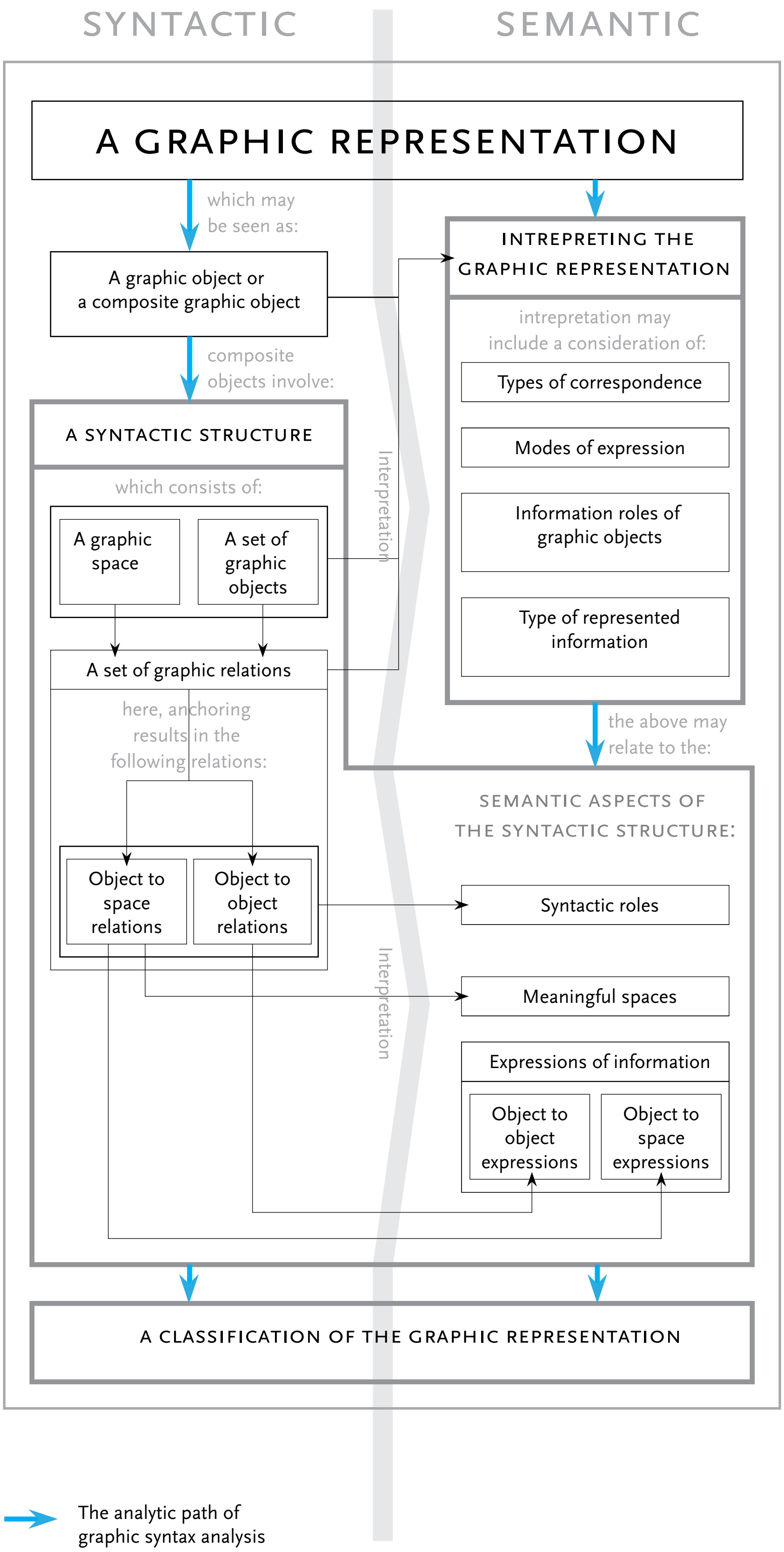


Fig. 2.6 A diagrammatic overview of Engelhardt's graphic syntax theory. We see that a division has been made between those elements that are seen as syntactic and those that emerge in semantic analysis. Further, the recommended analytic path is highlighted in blue.

This overview extends beyond anything offered in Engelhardt's own thesis. Indeed, others contributing to the field of information design have regretted the absence of such an overview (e.g. Mølhave 2010:37). As such, it is seen as a minor contribution.

Having provided the above overview of Engelhardt's theory, we will now end this section by briefly considering how the analytic framework is to be applied within this enquiry.

2.1.5.4 *Applying the Framework*

At the opening of *The Language of Graphics*, Engelhardt makes clear that his focus is directed towards static rather than dynamic and interactive graphics. Despite this, he goes on to claim most of his concepts '*do* apply to dynamic and interactive representations'. This is qualified by the admission that animation and interaction involve 'several additional concepts', which are not accounted for in the thesis (2002:10). From this admission, it is stated that the thesis may be seen as a 'first step' towards developing an understanding of the dynamic and interactive aspects of visual representation.

It appears as though no subsequent work has been undertaken in this area either by Engelhardt or other authors. This is regrettable as it would seem that defining the general principles of a dynamic and interactive visual language, would be of immense theoretical value, particularly from an information design perspective. As such, we may first off say that in applying Engelhardt's framework in this enquiry we are trialling the theory's concepts in relation to the dynamic and interactive aspects of our graphic representation with a view to offering a reflection in relation to their applicability and possible adaption or extension. This is seen to align with the second research question set out in Section 1.1. Here, it was stated that, from investigating how GPS-enabled WIS might be designed to visually support situation awareness in use, the resultant implications for information design theory would be identified. This reflection will be offered in Chapter 6 (see Section 6.3.2).

From this, in more immediate terms—as was the original intention of this review of information design theory—the identification of theory's notion of graphic syntax provides us with a useful *descriptive* framework to apply within the research. Thus, from the off, we may view GPS-enabled WIS as *composite graphic objects* consisting of a *graphic space* (e.g. the screen area), which contains *other* graphic objects (e.g. symbols). Such a conceptualisation has two benefits.

On the one hand, this allows us to make consistent references to elements within, and aspects of the interface designs which are to be generated within this enquiry. We may refer to this as *decomposing* the graphic syntax. On the other hand, by reversing the framework, that is by starting with the 'elementary graphic objects' and working upwards, we are *also* provided with a *conceptual tool* that allows us to *initiate* early design experiments within this practice-based enquiry. We may refer to this as *composing* the graphic syntax.

Both approaches are consistent with Engelhardt's own vision for his work. In outlining the contributions of his thesis he states that:

> 'The proposed concepts concerning the composition and decomposition of syntactic structures could be used to generate and discuss different design alternatives for a given graphic representation problem.'
>
> (Engelhardt 2002:163)

In addition to the above, the present enquiry takes a further step. Having generated a final prototype interface, i.e. a *practical* response to the research question, the framework is formally applied in order to analyse and, accordingly, define the interface's syntax. This definition is then contextualised, i.e. framed by the enquiry's point of origin and results. Such a contextualisation, in turn, provides an outline of the practical knowledge that the prototype interface is seen to embody. Thereby, the enquiry's transferability (Lincoln and Guba 1985; see Section 3.1.4.1) is enhanced.

Thus, we have discussed the field of information design, as well as outlined graphic syntax theory. We will now move on to unpack the dimensions of the activity bound up within the specific use-context of this research: urban recreational walking/wandering.

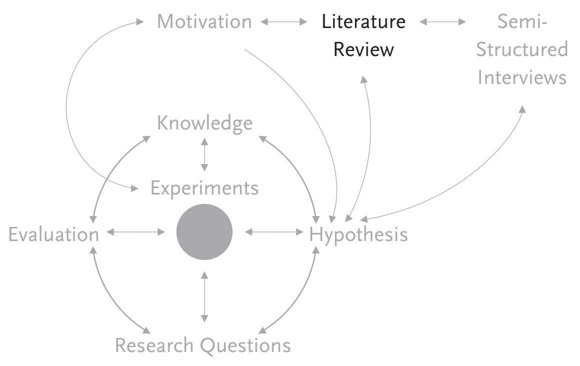


Figure 2.7 Literature Review Diagram Section 2.2

Discipline | Technological Platform | Activity

General | *Specific* | *Specific* | *General*

Information Design

Information Design Theory
Bateman, J., 2008,
Multimodality and Genre
Bertin, J., 2011/1967,
The Semiology of Graphics
Engelhardt, Y., 2002,
The Language of Graphics - a framework for the analysis of syntax and meaning in maps, charts and diagrams
Goldsmith, E., 1980,
'Comprehensibility of Illustration – an analytic model'
Horn, R., 1999,
'What is Information Design? Information Design as an Emerging Profession'
Jacobson, R., 1999,
Information Design
Kitchen, R., & Dodge, M., 2007,
'Rethinking Maps'
MacEachren, A., 1995,
How Maps Work
Perkins, C., 2008,
'Cultures of Map Use'
Richards, C., 1984,
Diagrammatics
Tufte, E., 1990,
Envisioning Information
Walker, S., 2014/2001,
Typography and Language in Everyday Life
Waller, R., 1987,
The typographic contribution to language
Ware, C., 2004,
Information, Visualisation – Perception for Design

Cognitive Psychology
Endsley, M., & Jones, D., 2012,
Designing for Situation Awareness

Wayfinding

General
Arthur, R., & Passini, P., 1992,
Wayfinding: People, Signs, Architecture
Baines, P., & Dixon, C., 2004,
Signs: Lettering in the Environment
Fendley, T., 2009,
'Making sense of the city: a collection of design principles for urban wayfinding'
Lynch, K., 1960,
The Image of the City
Mollerup, P., 2005,
Wayshowing
Mollerup, P., 2013,
Wayshowing >Wayfinding, Basic and Interactive

Mobile Wayfinding
Brown, B., & Chalmers, M., 2003,
'Tourism and mobile technology'

Wayfinding Interface Design

Cartographic Design and Mobile HCI
Cartwright, W., Peterson, M.P., & Gartner, G., 2007,
Multimedia Cartography
Gartner, G., & Uhlirz, S., 2002,
'Catographic Concepts for realizing a Location Based UMTS Service: Vienna City Guide "Lol@"'
Elias, B., & Paelke, V., 2005,
'User centre design of landmark visualizations'
Koch, W.G., 2000,
'Jaques Bertin's theory of graphics and it's devlopment and influence on multimedia cartography'
Meng, L., 2005,
'7 Egocentres of mobile users and egocentric map design'
Reichenbacher, T., 2004,
Mobile Cartography – Adaptive Visualisation of Geographic Information on Mobile Devices

GPS-enabled Technology

General Technology
Dourish, P., 2004,
Where the Action is
Suchman, L., 2007/1987,
Human-Computer Reconfigurations, Plans and Situated Actions

Mobile Technology
McCarthy, J., & Wright, P., 2004
Technology as Experience
Willis, K., Hölscher, C., Wilbertz, G., & Li, C., 2009, 'A comparison of spatial knowledge acquisition with maps and mobile maps'

Recreational Walking

Edensor, T., 2000,
'Moving through the City'
Middleton, J., 2009,
'Stepping in time': walking, time, and space in the city'
Middleton, J., 2010,
The 'Walkable City': the dimensions of walking and overlapping walks of life'
Solnit, R., 2000,
Wanderlust: A History of Walking
Wyllie, J., 2006,
'Depths and Folds: on Landscape and the Gazing Subject'

Human-Spatial Interaction

Human Geography
Massey, D., 2005,
For Space

Anthropology
Ingold, T., 2000,
The Perception of the Environment

Sociology
deCerteau, M., 1984,
The Practice of Everyday Life
Urry, J., 2007,
Mobilities

Ecological Pyschology
Gibson, J., 1986,
The Ecological Approach to Visual Perception

Cultural Studies / History
Bagwell, P., 1974,
The Transport Revolution
Benjamin, W., 1999,
The Arcades Project

Literary Criticism
Wallace, A., 1993,
Walking, Literature and English Culture

Philosophies of Embodiment and Place

2.2 The Activity of Recreational Walking

These texts consider the dimensions of the activity of urban recreational walking/wandering. Focus is either directed towards the affects of the environment on walking and the walker (i.e. deCerteau 1984; Edensor 2000), or the effects of walking as an activity (i.e. Middleton 2010).

2.2 The Activity of Urban Recreational Walking/Wandering

In considering the activity of urban recreational walking/wandering as the specific use-context of this research, we shall first briefly trace the historical emergence of the activity through the character of the flâneur. From this, a series of theoretical linkages are drawn with work undertaken in the fields of sociology and human geography. These linkages allow us to frame an understanding of the activity's dimensions.

2.2.1 *The Flâneur as an Archetype in the History of the Activity of Urban Recreational Walking/Wandering*

In terms of providing a historical outline of the development of the activity of urban recreational walking/wandering, two key texts are here identified as significant. The first is Walter Benjamin's *The Arcades Project* (1999). Through a discussion of the early nineteenth shopping arcades of Paris, Benjamin introduces the figure of the flâneur; an aimless stroller who, through wandering, seeks to immerse themselves in the crowd and observe the movement of the city from this detached position. The second work is Rebecca Solnit's *Wanderlust* (2000). Solnit contextualises Benjamin's writing within a larger overview of urban walking, noting how the act of strolling through a city has always afforded 'anonymity, variety and conjunction' (p.171). Though she casts doubt on the possibility that flâneur-like individuals ever existed, others have drawn parallels between the character and contemporary recreational practices. For example, in *The Tourist Gaze* Urry and Larsen propose that the 'strolling flâneur was the forerunner of the twentieth-century tourist and the taking of photographs – of being seen and recorded, and of seeing others and recording' (2011:162). For our present purposes, the character of the flâneur may best be understood as an archetype, a representative of a particular *attitude*. An attitude that Jenks, in discussing the flâneur, calls a 'creative attitude of urban inquisition' (1995:156-157). It is this attitude which is seen to underpin the contemporary practice.

2.2.2 *The Dimensions of Urban Recreational Walking/Wandering*

As a contemporary subject, discussions on urban recreational walking/wandering tend to be incorporated into larger, more general explorations of urban walking as a whole. Accordingly, we must extract or infer relevant insight from these broader characterisations. The contributors identified below, tend to apply one of two lenses when discussing the activity of urban walking. Focus is either directed towards the *affects* of the environment on walking and the walker (i.e. deCerteau 1984; Edensor 2000), or the *effects of* walking as an activity (i.e. Middleton 2010, 2009, 2011). Though those in the former category, i.e. those dealing with affects, might be seen as leaning more toward a discussion of environmental relations (see Section 2.3) than urban walking, they are included here due to their focus on urban walking/wandering.

We begin with deCerteau's 'Walking in the City'. Appearing as a chapter in *The Practice of Everyday Life* (deCerteau 1984), it provides what is perhaps one of the most prominent accounts of urban walking yet written. deCerteau outlines an understanding of walking as situated and experiential, ultimately unrecoverable beyond the act itself. Perhaps one of the most compelling claims put forward is that by moving through a place the walker is seen to actualise the space (p.98). Here, deCerteau suggests that the possibilities of place are brought about through walking. Further to this, deCerteau also asserts that the walker, in walking, 'lacks place' (i.e. does not hold a fixed position) and is involved in 'the indefinite process of being absent' as they move toward an eventual endpoint (p.103). This would appear to imply that the walker is constantly focusing on a destination, but it is held that deCerteau is instead celebrating the *perpetual onwards push* that the activity facilitates.

In a recreational sense, we can understand this 'perpetual onwards push' as relying on an openness toward time. Such an understanding connects with Otto Friedrich Bollnow's definition of 'wandering'. For Bollnow, wandering is the pursuit of 'a leisurely, lengthy and coherent movement on foot from one place to another, not driven by urgency or undertaken for some external purpose' (2011/1963:106). Bollnow goes on to state that '[t]he release from purpose is the dominant characteristic of wandering' and that the wanderer does not see a 'destination' as important but rather '"being on one's way"' (ibid:110).

Exploring this notion of openness to both space and time in an urban context, Edensor (2000) outlines various ways in which the body and the performative potential of its movement is regulated by the structuring of the contemporary city. Though Edensor does not explicitly mention recreational practices as a means through which urban space can be accessed, it is here seen as appropriate to take 'moving' as inclusive of recreational walking/wandering. From Edensor's point of view, urban movement is both encouraged and 'staged'. Encouraged in the sense that 'paths, stairs, openings, [and] tactile surfaces' are seen to 'invite physical exploration'. Staged in the sense that it takes place in a limited performance space with a range of physical, social and cultural constraints (p.123). In his conclusion, Edensor argues in favour of disruption, stating: 'we should celebrate and foster spaces which contain confusion and the energy created by contrasts and clashes'. Here, the power of disruption is seen to lie 'in its potential to dramatize and reveal the complexities of co-existence, and friction that permeate the city' (p.136). The last remarks point not only to the special value of spatial/cultural diversity, but also to the idea that witnessing existent complexities and frictions (e.g. visible poverty, and social inequality) is desirable.

Massey (2005) concurs with the above view, identifying one of the 'most truly productive aspects of material spatiality' as:

> '...its potential for the happenstance juxtaposition of previously unrelated trajectories, that business of walking around a corner and bumping into alterity, of having (somehow, well or badly) to get on with neighbours who got "here"... This is an aspect of the productiveness of spatiality which may enable something new to happen.'
>
> (Massey 2005:94)

Exploring some of the above propositions, through empirical investigation, Jennie Middleton (2010) presents a Ph.D. thesis detailing the multiple ways in which walking is practiced and experienced in the contemporary city. While urban recreational walking/wandering features in this work, it is not the central focus. Instead, by tracing pedestrian movement through the experience of London-based participants, Middleton uncovers some of the multiple, overlapping dimensions of walking. It is thus revealed as a complex and heterogeneous activity deeply embedded in the coordination of daily life.

Developing this work further through a number of journal publications, Middleton connects the activity's spatial and temporal dimensions with themes such as identity, sociality and technology. For example, in *"Stepping in time": walking, time, and space in the city* (Middleton 2009) there is an emphasis on the temporal. We are told that walking is not experienced as 'clock time', but instead 'is made up of multiple temporalities which emerge out of, and shape, people's experiences on foot' (2009:1958). Middleton also claims that walking enables multiple spatialites that are ultimately dependent on levels of physical mobility. Here, she offers the example of a participant who suffers from a physical disability and elaborates on how, for this participant, walking distances are a paramount concern. This example is said to illustrate the way space is both 'sensually and emotionally apprehended' in walking (p.1955).

Through all of the above publications, Middleton offers a suite of policy recommendations. She takes the position that while walking is currently high on transport and academic agendas, attention is most often directed towards measures of speed and efficiency. Ultimately, it is her central argument that this perspective does not connect with the experience of walkers. She insists that only *experiential* understandings of walking are adequate if the activity is to be promoted effectively.

We have thereby outlined a range of prominent perspectives on the activity of urban walking/wandering. Before moving on it will be helpful to gather together these so that a definition of urban recreational walking/wandering may be offered.

Urban recreational walking/wandering—when viewed as a component of urban walking—may be seen as an activity through which the walker *actualises* the possibilities of place (deCerteau 1984:98). Additionally, walkers, in walking, may be said to engage in a *perpetual onwards push* (i.e. not holding a fixed location but rather moving toward a destination; ibid:103). In a recreational sense, this requires that an openness toward time be maintained. Such an openness, is seen to underpin the act of 'wandering' (Bollnow 2011:106). Herein, by accepting the invitation of various features of the urban environment (Edensor 2000), alterity and complexity can be witnessed and experienced. Framed in positive terms, this can allow for 'something new to happen' (Massey 2005). Beyond the above, in a general sense, urban walking is also seen to enable a number of experiential realities, which are only available through the activity itself. These relate both to time and to spatial practice, and in turn are seen as supporting the construction of particular identities relating to embodied ability (Middleton 2009).

Thus we define the activity urban recreational walking/wandering as

> *an embodied process wherein a walker moves through a given, possibly unfamiliar, urban environment; and therein observes, experiences and affects/is affected by environmental and/or social conditions.*

Having formulated the above definition, we will now expand our focus to consider the walker's *embodied involvement* in their surrounding environment, as well as how this involvement is mediated by technologies such as GPS-enabled WIS.

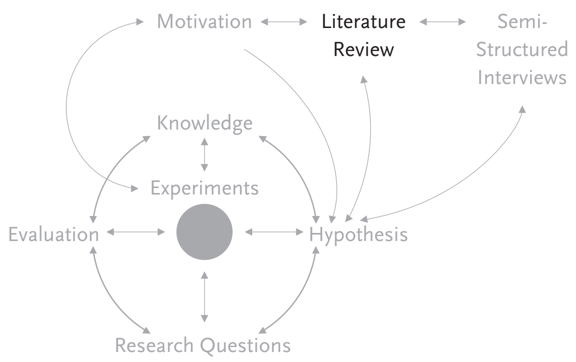


Figure 2.8 Literature Review Diagram Section 2.3

Discipline — Technological Platform — Activity

General — *Specific* — *Specific* — *General*

2.3 The Walker's Experience of the Environment and the Mediation of that Experience

2.3.1
These texts will outline philosophical, geographical and anthropological perspectives on what it is to be situated.

2.3.2
These texts will present two approaches to the study of wayfinding: the cognitive and the ecological.

2.3.3
These texts will define wayfinding design as an information design practice.

2.3.4
These texts will link interaction design and information design.

2.3.5
These texts will set out and discuss aspects of GPS-enabled interface design.

2.3.6
These texts will set out the key issues and research directions relating to the use of GPS-enabled wayfinding interfaces.

2.3.7
The concept of 'situation awareness' is defined within this research.

Wayfinding

General

Arthur, R., & Passini, P., 1992,
Wayfinding: People, Signs, Architecture
Baines, P., & Dixon, C., 2004,
Signs: Lettering in the Environment
Fendley, T., 2009,
'Making sense of the city: a collection of design principles for urban wayfinding'
Lynch, K., 1960,
The Image of the City
Mollerup, P., 2005,
Wayshowing
Mollerup, P., 2013,
Wayshowing >Wayfinding, Basic and Interactive

Mobile Wayfinding

Brown, B., & Chalmers, M., 2003,
'Tourism and mobile technology'

Wayfinding Interface Design

Cartographic Design and Mobile HCI

Cartwright, W., Peterson, M.P., & Gartner, G., 2007,
Multimedia Cartography
Gartner, G., Uhlirz, S., 2002,
'Catographic Concepts for realizing a Location Based UMTS Service: Vienna City Guide "Lol@"'
Elias, B., & Paelke, V., 2005,
'User centre design of landmark visualizations'
Koch, W.G., 2000,
'Jaques Bertin's theory of graphics and it's devlopment and influence on multimedia cartography'
Meng, L., 2005,
'7 Egocentres of mobile users and egocentric map design'
Reichenbacher, T., 2004,
Mobile Cartography – Adaptive Visualisation of Geographic Information on Mobile Devices

GPS-enabled Technology

General Technology

Dourish, P., 2004,
Where the Action is
Suchman, L., 2007/1987,
Human-Computer Reconfigurations, Plans and Situated Actions

Mobile Technology

McCarthy, J., & Wright, P., 2004
Technology as Experience
Willis, K., Hölscher, C., & Wilbertz, G., Li, C., 2009, 'A comparison of spatial knowledge acquisition with maps and mobile maps'

Recreational Walking

Edensor, T., 2008,
'Walking through Ruins'
Marples, M., 1959,
Shanks's Pony: A Study of Walking
Middleton, J., 2009,
'Stepping in time': walking, time, and space in the city'
Middleton, J., 2010,
The 'Walkable City': the dimensions of walking and overlapping walks of life'
Solnit, R., 2000,
Wanderlust: A History of Walking
Wyllie, J., 2006,
'Depths and Folds: on Landscape and the Gazing Subject'

Human-Spatial Interaction

Human Geography

Massey, D., 2005,
For Space

Anthropology

Ingold, T., 2000,
The Perception of the Environment

Sociology

deCerteau, M., 1984,
The Practice of Everyday Life
Urry, J., 2007,
Mobilities

Ecological Pyschology

Gibson, J., 1986,
The Ecological Approach to Visual Perception

Cultural Studies / History

Bagwell, P., 1974,
The Transport Revolution
Benjamin, W., 1999,
The Arcades Project

Literary Criticism

Wallace, A., 1993,
Walking, Literature and English Culture

Philosophies of Embodiment and Place

Bollnow, O., 2011/1963,
Human Space
Casey, E., 1997,
The Fate of Place
Husserl, E., 1981/1932,
'The World of the Living Present and the Constitution of the Surrounding World to the Organism'
Ihde, D., 1990,
Technology and the Lifeworld
Ihde, D., 2009,
Postphenomenology and Technoscience

2.3 The Walker's/Wanderer's Experience of the Environment and the Mediation of that Experience

Within this enquiry, the walker's/wanderer's experience of the environment is seen as being grounded in their embodied involvement in that environment, i.e. their *situation*. The view is taken that, in wayfinding, this experience may be mediated through graphic representations such as signage, maps and GPS-enabled interfaces, i.e. the products of *wayfinding design* and *interaction design*. Here, in considering this mediation, the psychological concept of *situation awareness* is highlighted and appropriated for the purposes of the present research.

We begin this section, then, by exploring theoretical perspectives relating to the notion of embodied involvement in the surrounding environment, i.e. the situation.

2.3.1 Philosophical, Human Geographical, and Anthropological Perspectives on the Concept of Being in a 'Situation'

Philosophy, human geography, and anthropology are all seen to contain theoretical perspectives which, to varying degrees, offer understandings of embodied involvement in a surrounding environment, i.e. of being in a 'situation'. What follows is not intended to act as an exhaustive review of all writing concerned with the subject. Though such a project would be valuable, it is beyond the scope of the present enquiry. Rather, what follows is intended as an outline, as well as an interweaving, of perspectives with which this enquiry identifies.

We will begin with philosophy, wherein the nature of the environment and embodied involvement within it has been examined over many centuries. Edward Casey (1997) offers a helpful overview of how this thinking has evolved. The work of Newton is cited as marking a critical moment wherein meaningful understandings of 'place' as a tangible referent, were 'dissolved' within scientific discourse and replaced by an abstract conception of infinite, empty 'space' (p.146). We are told that by the beginning of the eighteenth century 'space was increasingly regarded as nothing but as set of positions' (p.186). It was not until the onset of the twentieth century that a counter-argument, which begins to foreground the body, was mobilised by those offering a *phenomenological* perspective.

Phenomenology is, quite literally, concerned with that study of 'phenomenon', that is with *how* things *appear* (e.g. problems, objects, events) to be to *someone* (Lewis and

Staehler 2010:1). More specifically, it is concerned with the study of *how things* appear to *consciousness* as we experience intentional action (Moran 2010:6). Here, consciousness is seen as *the* link between what occurs at a point in time and how this *occurrence* is apprehended based on prior experience (Mohanty 1997:2). Within such a framing, it is possible to assert that the world may be understood as being *constituted* through *consciousness*, i.e. *brought* into *being* through consciousness (ibid).

Among the most prominent philosophers to be associated with phenomenology, we find its founder Edmund Husserl. For our present purposes, one of his later essays, *The World of the Living Present and the Constitution of the Surrounding World to the Organism* (1981/1932), is drawn upon. In this essay Husserl explores how the surrounding environment is experienced in movement. Though short, and at times challenging, it provides the present enquiry with three key starting-points that will allow us to begin to frame environmental relations.

First, Husserl states that the world can be seen as a 'totality of perspectives', i.e. lines of sight, which fit together in movement and so allow the world to be experienced as a 'unity' (p.239). In this way, he is proposing that seeing and knowing the world, as a continuous, seamless experience, emerges in movement as we draw together all possible lines of sight.

Second, in the essay's final section the focus turns entirely to the experience of walking. Here, Husserl cites how, in walking, humans relate to their surroundings on the basis of their own 'absolute here':

> 'If walking begins, all worldly things there for me continue to appear to me to be orientated about my phenomenally stationary, resting organism. That is they are orientated with respect to here and there, right and left, etc., whereby a firm zero of orientation persists, so to speak as absolute here.'
> (Husserl 1981/1932:249-250)

Husserl is stating that through embodiment, movement is experienced in relation to the constant 'here' of the body, which imposes its own orientational framework. As Husserl points out, this framework is usually based on associations such as here and there, right and left.

Third, in the essay's final paragraphs this reference to walking as an orientating activity is developed further. Husserl proposes that the 'stable null-object' of the body can, through walking, be made to become contiguous with other things and so 'the earth' may be understood as 'already a system of places' (p.250). Walking then, is understood as enabling place and, moreover, constitutive of the world.

> 'Clearly the fixed system of places of external things available perspectivally to me is already constituted by means of self-moving, as is also the fact that I can bring my animate organism close to every thing and object [...] directly, on the "surface of the earth..."'
> (ibid:250)

This enquiry therefore grounds its understanding of our embodied involvement in a surrounding environment on these three propositions: that seeing and knowing the world as a whole can be understood as emerging through movement; that in walking we experience our position as an 'an absolute here'; and finally that the world is constituted in 'self-moving', i.e. by walking we enable place.

From the above, we now turn to the work of Doreen Massey. Writing as a human geographer, Massey offers us a complimentary perspective, that builds on the last of the above three propositions from Husserl (i.e. that the world is constituted in 'self-moving'). Specifically, in *For Space* (2005), she argues that we should attempt an imaginative leap and see space as a 'multiplicity' of realties, rather than a single, synchronic surface. 'Here' as a thing, for Massey, 'is where spatial narratives meet-up or form configurations, conjunctions of trajectories which have their own temporalities' (p.139). Held within our own set of environmental relations, in our own 'heres' as it were, we are enmeshed within a grand series of *intersecting* spatial dialogues. On this view, place is understood as an 'event' where these dialogues meet: 'a constellation of processes rather than a thing.' Thus, for Massey, there is no absolute stability or completeness only a constant on-going negotiation (p.141).

In common with Massey, social anthropologist Tim Ingold also strongly rejects conventional notions of space or, within his focus, 'landscape', as a fixed surface. In doing so, he pushes for a more reciprocal understanding of embodied involvement in the environment. Here, rather than seeing the body and the environment as independent and already formed, we are told that both the body and the landscape are 'generated and sustained in and through the processual unfolding of a total field of relations'. Embodiment is therefore regarded as 'a movement of incorporation rather than inscription' (2000:193).

Adding to the above, Ingold evokes the notion of 'temporality', wherein the concepts of *time* and *history* are merged. Such merging is seen to take place through the experience of those who 'carry forward the process of social life' through activities (p.194). Within this interweaving of embodiment and temporality, the 'landscape' is now recast as a 'taskscape'. This renaming is part of an effort to move away from an understanding of landscape as something that a single agent experiences in isolation, to one that is populated by agents who can, and do, act back. 'The taskscape' he writes 'exists not just as activity but as interactivity' (p.199). Again we are asked to make an imaginative leap towards multiplicity.

Following on from Ingold, a final noteworthy framing of environmental experience comes from human geographer John Wyllie. In *Depths and folds: landscape and the gazing subject*, Wyllie (2006) seeks to renew our understanding of the *visual gaze* upon the landscape through an exploration of the philosophical concepts of 'depth' and 'fold'. Attempting to push beyond Ingold's 'residually intentional subjectivity', he argues that 'landscape' must be approached as an 'immanent, processual topography', wherein:

> '...some actualisations, some sets of relations between self and landscape, are eventful and iterative. They convince, and propel forward, through continual subtle differentiation and refraction. They become, in other words, cultures of landscape, mobile and morphing ensembles of topographies, bodies and percepts.'
>
> (Wyllie 2006:533)

Although Wyllie sees his paper as presenting a version of landscape that is 'anterior' to Ingold's above-described 'taskscape', within this review the two are seen to connect. The word 'actualisation' holds the key. In order to experience social activity and so participate in the landscape's/taskscape's temporality, the walker/wanderer *must* actualise their *own* landscape, in our case an *urban* landscape. Thereafter, they have no choice but to move forward based on their appropriations of what this landscape is, i.e. what it *means* and how it is *understood*. The urban walker/wanderer is therefore carrying forward the urban landscape's temporality *through* their experience of social activity. They actualise and reactualise as they walk.

We will now briefly retrace the above positions such that we may gain an overarching appreciation of the ways in which they, together, inform the present enquiry. From Husserl's phenomenology, we can understand continuous perception of the environment as emerging out of the assimilation of the multiple lines of sight that moving affords. We also take the notion of the embodied 'absolute here' as imposing its own orientational framework, grounded in associations such as here and there, right and left. Finally, places are seen as being constituted through a process of 'self-moving', of bringing the 'animate organism', i.e. the body, close to 'every thing and object' (Husserl 1981/1932). Then from this, we are able to reject the idea of space as surface (Massey 2005) and we can instead see the walker and their activities as relating to a larger 'taskscape', i.e. a temporal and interactive understanding of landscape (Ingold 2000). Finally, connecting to this, we understand the walker's temporal and interactive environmental relations as being based in iterative actualisations of an experienced, eventual urban landscape (Wyllie 2006).

Thus we have grounded the above understanding of how an urban recreational walker/wanderer is involved in the surrounding environment, i.e. how they are in a 'situation'. We will now move to define the process by which they may act to change their situation, i.e. the process of wayfinding.

2.3.2 *Wayfinding: Cognitive and Ecological Perspectives*

Literature relating to the process of wayfinding, is seen to identify with one of two separate perspectives: the 'cognitive', or the 'ecological'.

The cognitive perspective takes the concept of the cognitive map (Tolman 1948) as its foundation. The word 'map' is here applied in a metaphoric sense to account for a person's ability to construct an overall mental impression of the environment. Then, linking to the concept of the cognitive map, 'wayfinding' refers to the dynamic aspect of a person's movement as they navigate through an environment (e.g. Kaplan 1976; Passini 1977, 1984; Golledge 1999). Three interdependent cognitive processes are seen to underpin this activity. These are: decision making, decision execution and information processing (Arthur and Passini 1992:17).

From the late 1960s onwards, a series of studies began to establish the key aspects of the human wayfinding process. In terms of the content of cognitive maps, such studies have identified that: frequently traveled routes are used as anchor points in the structuring process (Golledge 1978); as are landmarks (Couclelis et al. 1987); and wayfinding across an unknown environment while moving towards a known site contributes to the development of cognitive maps (Rieser et al. 1982). In terms of the use of cognitive maps, some key studies and academic gatherings have considered how the cognitive map is deployed when: we select routes (Passini 1980); we determine the relative direction of a site or group of sites (Loftus 1978; Shepard and Huritz 1984; Haber et al. 1993); and when we recognise we're lost (Montello and Lemberg 1995).

Through the contribution of multiple authors. Golledge's *Wayfinding Behavior: Cognitive mapping and other spatial processes* (1999) provides a wide-ranging survey of the results of decades worth of research. Additionally, the text links work undertaken in cognitive psychology with cognitive neuroscience and is particularly noteworthy as it claims to be the first publication to draw together findings relating to both human and non-human (i.e. animals' and insects') wayfinding,

While few have questioned the consensus that has developed in relation to the above perspective, some have questioned the cognitive map metaphor (e.g. Kuipers 1983; Ingold 2000). There has also been criticism of the focus of the research. Here, Gluck (1991) has suggested that rather than considering issues relating to individuals' competency and performance, wayfinding researchers might apply what he refers to as the 'sense-making method' to investigate wayfinding and, in doing so, develop a more detailed understanding of the richness inherent within the actual process.

In a similar vein, the ecological perspective on wayfinding diverges from traditional approaches taken in cognitive psychology. This perspective is seen to emerge from the work of psychologist James Gibson. Gibson rejected conventional approaches to research on perception, wherein perception was studied independently of action (Dourish 2004:117). In seeking to address this, he outlined a theory of perception, which acknowledges the embodied, situated aspect of all perceptual processes by arguing that our perception of the environment is direct and unmediated (Gibson 1986/1979).

Within this theory, presented in the 1979 text *The Ecological Approach to Visual Perception*, we encounter the notion of 'ambulatory vision'. Here, in a similar fashion to Husserl (see

Section 2.3.1 above), Gibson claimed that rather than seeing from a stationary 'fixed point of observation' the walker sees from 'a travelling point of observation' (1986/1979:197). This 'ambulatory vision' allows the walker to collect together a series of 'vistas' or sight-lines, each of which is essentially unique and therefore enables recognition.

> 'One vista leads to another in a continuous set of reversible transitions. Note in the terrestrial environment of semi-enclosed places each vista is unique, unlike the featureless passageways of a maze. Each vista is thus its own "landmark" inasmuch as the habit never duplicates itself. When the vistas have been put in order by exploratory locomotion, the invariant structure of the house, the town, or the whole habitat will be apprehended.'
>
> (Gibson 1986/1979:198)

Gibson goes on to claim that over an extended period of time, involving a multiple criss-crossings of routes, the walker is able to compose a total image of their environment (ibid:198). Thus it is only through 'exploratory locomotion' (i.e. walking in unfamiliar places) that this total image can be constructed.

One of the most active advocates of the ecological perspective has been Harry Heft, an environmental psychologist working in the United States. From the late 1970s onwards, Heft has consistently presented arguments calling for the adoption of Gibson's model by those conducting research in the field of environmental psychology (e.g. Heft 1981, 1983, 1996, 2013). In his early work, he drew a contrast between cognitive accounts of the perceptive process and the Gibsonian (i.e. Heft 1981, 1986). Later, he presented the results of a number of experiments, which provide evidence supporting the ecological account of perception (Heft 1996). Additionally, in one of his most recent contributions (2013), Heft puts forward the view that social-historical factors may be central (as opposed to merely supplementary) to the process of an individual forming and structuring a cognitive map. Interestingly, Walton (2014) has recently argued that wayfinding designers would benefit from drawing inspiration from this work, taking on board its theoretical and methodological implications.

Further to Heft, Gibson's model has also received attention from Tim Ingold. Ingold works to extend the original Gibsonian position by arguing that wayfinding can be understood as both 'improvisary and assured'. That is, in wayfinding, we both learn and know at the same time.

A final noteworthy contribution comes from Kevin Lynch (1960). Though Lynch's work predates Gibson's (i.e. 1986/1979), it is seen to align well with this perspective. Based on empirical findings from research undertaken in the United States, Lynch proposes that wayfinders rely on five key elements as they wayfind in an urban environment. These elements are: paths, edges, nodes, districts and landmarks (1960:46). Each elemental category may be understood as loosely encompassing a broad range of possible forms. For example, paths may be 'streets, walkways, transit lines, canals, railroads' (p.47). Equally, landmarks may be 'a building, sign, store or mountain' (p.48).

Lynch also argues it is only by moving through the environment that such elements may come to be known. Within this process of moving, the environment is seen to suggest distinctions and relations and the observer 'selects, organises and endows with meaning what he sees'. In this way, an 'image' of the city is formed (p.6).

In comparing the cognitive and ecological perspectives, this enquiry identifies with the latter due to its emphasis on embodied perception and knowing, as well as the explicit incorporation of walking within the model. In short, the ecological perspective aligns with the understanding of how an urban recreational walker/wanderer is seen to be involved in the surrounding environment, i.e. how they are in a 'situation' (see Section 2.3.1). Consequently, for the purposes of this enquiry, wayfinding is defined as

> an embodied process wherein embodied perception and embodied understanding allows a walker to link together and comprehend a series of seen vistas along a route through a given, possibly unfamiliar, environment.

Having considered and defined wayfinding, we will now move on to look at wayfinding in urban recreational walking/wandering.

2.3.2.1 *Wayfinding in Urban Recreational Walking/Wandering*

As noted above (see Section 2.2.2), in wandering the urban recreational walker/wanderer may be seen to focus on the practice of the activity rather than its object, i.e. arrival at a destination (Bollnow 2011/1963:106). Thus, they remain open to various possibilities as they *move* through the city (Edensor 2000, Massey 2005). For example, 'paths, stairs, openings, [and] tactile surfaces' may 'invite physical exploration' (Edensor 2000:123). Within this framing, we are able to say that, in some cases, an urban recreational walker's/wanderer's wayfinding may be *based* on the *invitation to exploration* issued by the features of the urban environment and/or the social conditions. Accordingly, wayfinding in urban recreational walking/wandering may be understood as a form of 'exploratory wayfinding', wherein there can be no *fixed* plan or route in mind.

Thus, in order to consolidate the above, we will define *exploratory wayfinding* as

> *an embodied process wherein the walker observes, experiences and affects/is affected by environmental and/or social conditions as they link together and comprehend a series of seen vistas in a given, possibly unfamiliar environment, such that there is no fixed plan or route.*

From this definition, we will now turn to look at the area of wayfinding design and, in doing so, consider its treatment within the literature.

2.3.3 *Wayfinding Design as an Information Design Practice*

Within this enquiry, wayfinding design refers to the design of graphic representations (e.g. signage, maps or GPS-enabled interfaces) for the specific purpose of assisting a person as they move through a given environment. Thus, it is held to be an information design practice.

As with information design practice in general, instances of informal 'wayfinding design' can be traced through human history. In *The Image of the City*, Kevin Lynch notes that almost all human populations have sought to provide 'visual clarity' within their landscapes through constructions as simple as 'cairns, beacons or tree blazes' (1960:12-13). Similarly, writing of 'environmental communication' as an approach to 'design planning for wayfinding', Sergio Correa de Jesus argues that historically, the built environment was structured to assist and support 'recognition, reassurance and routine' (1994:34).

Beyond these informal structural/architectural approaches, a suite of more formal 'place markers' are seen to emerge as particular needs arise. For example, with Roman military expansion, and the subsequent consolidation of its road network, we see the arrival of the milestone (Baines and Dixon 2004:16). More recently, the development of dedicated, local signage can be linked to the advent of tourism generally, and recreational walking in particular (Wallace 1993:64). For example, in describing the social effects of the transport revolution in Britain during the nineteenth century, Philip Bagwell (1974) notes that the arrival of the railway on the Isle of Wight in 1864, led to local demand for the introduction of 'signposting' to 'beauty spots' (p.174).

Moving into the late twentieth century, the establishment of a formalised approach to wayfinding design is attributed to the architect Paul Arthur and the psychologist Romedi Passini. Together, the pair envisioned a practice that, in application, united various aspects of architectural, graphic and psychological knowledge (Passini 1984; Arthur and Passini 1992). According to their definition such a practice would extend beyond the design and placement of signage, and instead attend to all stages of a project; including the design of the environment itself. According to Passini, an ideal wayfinding system would provide information relating to spatial problem solving 'when and where users have to make a decision' (Passini 2000:90).

Over the last two to three decades, a number of prescriptive wayfinding design texts have been published (e.g. Arthur and Passini 1992; Mollerup 2005, 2013; Gibson 2009; Calori and Vanden-Eynden 2015). Though some of these texts are quite recent, few definitive statements relating to the digital are offered (though Mollorup (2013) does consider the use of mobile apps; see Section 2.3.6).

People, Architecture and Signs (Arthur and Passini 1992), *The Wayfinding Handbook: Information Design for Public Places* (Gibson 2009) and *Wayshowing* (Mollerup 2005) are perhaps the three most significant texts in this grouping. All offer a detailed outline of the underlying cognitive processes that are seen to direct human 'wayfinding behaviour' and set this alongside practical guidance for the application of this knowledge in the development of signage systems. However, apart from discussions relating to how landmarks and architectural features are encountered and recognised, these texts do not attend to the user's experience of embodied involvement in their surrounding environment. Others texts, also considering wayfinding design, set out surveys of successful practical examples and provide historical overviews; yet do not address any theoretical concerns relating to these (e.g. Fawcett-Tang 2008; Baines and Dixon 2004).

Beyond these larger works, a number of articles presenting wayfinding case-studies, which propose recommendations or principles have been published. Focus has been directed towards the development of wayfinding approaches in: airports (Mijksenaar 2005; Lam et al. 2013; Tam 2011), hospitals (e.g. Wright et al. 1990; Passini et al. 2000; Wright et al. 2010; Cheng and Pérez-Kriz 2014), cities (e.g. Fendley 2009; Schwanbeck 2013), and museums (e.g. Marino 1997; Fontaine 2014).

Increasingly, through journal publications, attention is now being directed towards the potential of digital wayfinding design. Here, numerous studies have looked at the area of digital signage offering directional information (e.g. Kray et al. 2005; Taher and Cheverst 2011; Langner and Kray 2011). Generally, the value of such systems is seen to relate to their improved flexibility, the possibility of readily adapting the content to suit immediate requirements, and efficiency. Huang and Gartner (2010) have also published a useful evaluation of contemporary indoor mobile navigation systems. They identify a number of areas for future research including: sensor fusion, context-awareness, route communication, the switch between indoor and outdoor navigation, and ubiquitous computing. Further to this, a considerable amount of work has been undertaken investigating how digital solutions might support those with blindness or visual impairment (e.g. Sáenz and Sánchez 2010; Hesch and Roumeliotis 2010).

Beyond these general studies, a number of researchers have looked at how the digital solutions might be best provided in specific museum contexts. A large portion of these consider how dynamic, multimodal visitor guides can enrich the visitor experience through location-aware personalisable information presentation (e.g. van Hage et al. 2010; Damala et al. 2012; Wakkery and Hatala 2007). Van Hage et al.'s (2010) work here, looked at how museum visitors could be provided with dynamic routes representations, which adapt based on their changing interests. Similarly, through Ph.D. research, Walker (2010) has investigated the potential of user-constructed trails on mobile platforms. Further, Cosley et al. (2009), considering collection navigation from an interpersonal perspective, developed a novel curatorial system entitled MobiTags, which groups user-generated notes, art information and a system map to support navigation. Through testing, users reported experiencing a strong sense of social presence in their navigation experience.

Alongside these museum contexts, work has also been undertaken in relation to heritage sites and online historical collections. Bollini and Falcone (2012) present a case-study focusing on an augmented reality project for Cimitero Monumentale di Milano, in Milan, Italy. The project aimed to provide users with a novel experience by digitally labeling real-world sites such as gravestones with otherwise unavailable contextual information, thus enriching their visit. Ibrahim, along with others (e.g. Ibrahim et al. 2011; Ibrahim et al. 2015), has done work looking at the possibilities of the virtual reality modeling of historical sites and, within this, begun to explore how users' wayfinding can be supported within such virtual environments. Ruecker et al. (2011), coming from a 'digital humanities' perspective, have presented a system which they refer to as 'rich prospect browsing'. Here, users of digital collections are presented with a meaningful representation of every item contained in that collection, which they can explore, manipulate and tag. It is this provision of a dynamic visual overview of the content, which is seen to add value (p.4).

Surveying the available literature on wayfinding design as a whole, two theoretical gaps are identified. First, while there is an established body of literature on wayfinding in contexts such as museums and historical sites, it appears that more could be done in other recreation-based areas. The view taken here is that exploring the arrangement of graphic content in graphic space to produce graphic representations for specific wayfinding use-contexts such as urban recreational walking would be useful. For example, though Arthur and Passini briefly discuss the activities and preferences of those engaged in 'recreational wayfinding' (1992:76), no theoretical resources or recommendations to practice are forthcoming. Second, while an increasing number of studies are focusing on digital wayfinding, few if any have considered how novel information design approaches might be applied in such cases. With the increasing use of handheld GPS-enabled technology, and the potential it affords from a visual perspective, it seems timely that knowledge in this area be developed.

Having identified these gaps it appears that, in order to move ahead, we must work to forge a connection between the areas of wayfinding design—as an information design practice—and interaction design. In doing so, it will then be possible to consider the two areas in tandem.

2.3.4 *Interaction Design*

Interaction design is seen to have emerged out of human-computer interaction design (HCI), i.e. the design of interactive computer systems for human use. More recently, the terms human and computer have faded from use and the title 'interaction design' has been widely adopted by those practicing within this area; reflecting the broader scope of what is being designed and researched. Elaborating on this shift, Rogers et al. (2011) note how 'many practitioners and designers, who in the 1990s would have described what they were doing as interface design or interactive systems design, now promote what they are doing as interaction design' (p.1).

This may reflect a major reorientation in the underlying philosophical assumptions of the practice, especially in relation to computing in general (Kuutti 1996:24). Since the mid-to-late 1980s there has been a shift away from cognitive approaches and information processing models, towards an increasing emphasis on the themes of *context*, *embodiment* and *action* (e.g. Suchman 2007/1987; Dourish 2007; Kapetlinin and Nardi 2006; McCarthy and Wright 2004).

Lucy Suchman's concept of 'situated action' (2007/1987) is seen as a pivotal contribution to the field. Here, Suchman made the simple, yet compelling argument that traditional approaches to computing ignored the fact that action is always situated and hence proved highly ineffective when attempting to deal with the complexity of real-world interactions. Writing more recently, Paul Dourish takes a similar view and, in doing so, calls for an approach to interaction design that places emphasis on what he terms 'embodied interaction'. Within this framing interaction between the user and the system is foregrounded so that interaction refers 'not only to what is being done, but also *how* it is being done' (2007:4, italics in original).

This enquiry aligns with these positions on the basis that we are directly addressing the *how* of an *embodied* user's *interaction* with an interface in the *situated context* of a particular activity, i.e. urban recreational walking/wandering.

Having drawn this alignment, we will now move to forge a connection between information design and interaction design.

2.3.4.1 *Interaction Design and Information Design*

Within this enquiry, interaction design is seen to connect with information design through a joint concern for the arrangement graphic content in a graphic space (i.e. the page/screen area). In this vein, Nathan Shedroff proposes that efforts be made to conceive of a new 'process' or practice, which he terms 'information interaction design' (1999:267-268). According to Shedroff, such a practice would be founded upon the notion that all experiences and products can be placed on a scale of interactivity ranging from completely passive to highly interactive. If an appropriate level of interactivity is applied in framing the information delivery within an experience or product, the user will be well positioned to gain knowledge. Drawing together his argument, Shedroff states:

> 'Instead of marching through a linear series of data chunks and reaching an inevitable conclusion, individual users can choose where, when, and how they approach the information. At its best, the data supplied can be a model of the larger matrix of information experience that surrounded the idea in its author's mind.'
>
> (Shedroff 1999:299)

Taking inspiration from Shedroff, we may accordingly conceive of an approach to information design, which incorporates the interactive by acknowledging and celebrating the agency of the user. In doing so, we are able to begin to give explicit consideration to the *use* of information design, through the notion of the user's 'information experience'. That is, to the 'when, where and how' of seeking information in the use-context (i.e. wayfinding as an urban recreational walker/wanderer). Thus, within this enquiry, the GPS-enabled WI is seen as an instance of information design with *interactive aspects* that is *used* in a *wayfinding context*. Accordingly, we may consider the GPS-enabled WI to be an instance both of wayfinding design (i.e. information design) and interaction design.

Having made this connection, we will now turn our attention at last to the GPS-enabled WI, looking at both its historical emergence, as well as its treatment within contemporary literature.

2.3.5 Wayfinding Design meets Interaction Design: The GPS-Enabled Wayfinding Interface

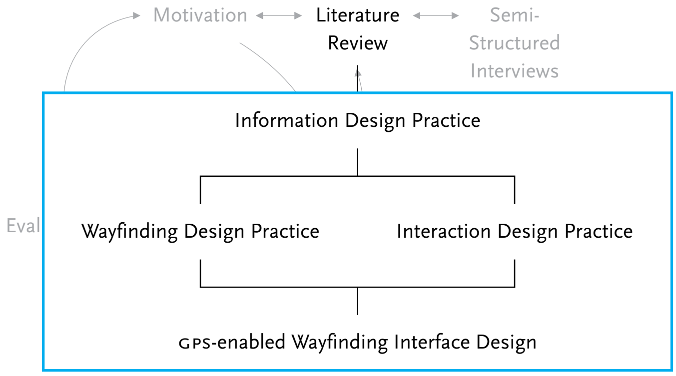


Fig. 2.9 Information design and its relationship to the focus of this research, GPS-enabled wayfinding interfaces.

The GPS-enabled WI is seen as an emergent entity, arriving at its present form through a variety of attempts to link handheld mobile technology, design approaches and various use-contexts[4].

One of the earliest examples of what we would now recognise as a WI, was produced by the LoL@ Project in Vienna (Gartner and Uhlirz 2001). The Lol@ research team set out to develop a map that could operate on a 'universal mobile telecommunications system' (UTMS), or what we would now refer to as a '3G network'. Their final output was a digital map for the Austrian capital, visually optimized for viewing on mobile telephone screens. Here, due to the constraints of the screen the team decided that the interface should be 'simple'. Accordingly, landmarks are shown in black silhouette and textual information is kept to a minimum.

Fig. 2.10 An overview of the city of Vienna as depicted by the LoL@ project's WI. Landmarks are shown in black and textual information is kept to a minimum (Gartner and Uhlirz 2001:4).

The first example of a working GPS-*enabled* WI was developed by Ericsson Eurolab's *OntheMove* project, as they investigated the potential of 3G networks. This project is among the earliest examples of the user's location being represented *within* the interface (Kreller et al. 1998).

Building on the above, Tumasch Reichenbacher's Ph.D. thesis explored the 'elaboration of adaptive methods for [the] visualisation of geographic information for mobile usage' (2004:3). Here, the ways in which the interface design might adapt to the user's context was investigated. While, the technical emphasis of this research has lost its immediate relevance, the theoretical framework, which draws together the user, their activity as well as 'the situation they are placed in', continues to hold currency. Additionally, Reichenbacher identifies a relevant area for future research, which we will cover in the next section (see Section 2.3.6 below).

As technology and WI design in general has matured, a tentative body of literature attending to practical design issues has begun to form around the subject. In terms of providing overviews of research and practice in this area, two texts—*Multimedia Cartography* (Cartwright et al. 2008) and *Map-based Mobile Services* (Meng et al. 2005)—are seen as helpful. Here, through the chapter contributions of various authors, we are offered the details of specific projects, along with principles relating to general areas of practice. While there are no contributions that specifically relate to the use-context of wayfinding as an urban recreational walker/wanderer, several chapters do deal with design for handheld mobile devices in general (e.g. Gartner 2008), and, others, with the *principles* of designing for GPS-enabled WIs (e.g. Meng et al. 2005). Of interest in regard to the latter, Elias and Paelke (2008) look at adaptive landmark visualisations. Here, the authors present what they refer to as a 'scale of abstraction' that might be applied in researching such visualisations[5]. Due to its perceived adaptability, this scale has been applied in early design experiments in this enquiry (see Section 5.2.1). Also of interest is Liqiu Meng's consideration of 'Ego centres of mobile users and egocentric map design'. Meng, here, provides an overview of 'egocentric' map design patterns, i.e. designs which centre the position of the user (2005). These are presented as an alternative to 'allocentric' approaches (i.e. those exhibiting a totalised perspective). Emphasis is placed on how the new capabilities of mobile devices provides the perfect platform for such patterns (p.88). However, while outlining the various constraints of the mobile interface, such as screen-size and the dynamic use-contexts, Meng states that 'mobile maps suit as a *communication vehicle* for well-defined user-tasks rather than a *thinking instrument*' (ibid, italics added).

Having discussed the historical emergence of GPS-enabled WIs, as well as their treatment within contemporary literature, we will now move on to consider a number of relevant recommendations and proposed research directions relating to their use in context, i.e. to interactions between the user, the interface design and the environment.

2.3.6 GPS-*Enabled Wayfinding Interface Use: Recommendations and Research Directions*

The *use* of GPS-enabled WIs is discussed within a number of fields, including cognitive science, urban studies, computer science and HCI. As noted above (see Section 2.3.3), standard perspective wayfinding design texts *do not* generally attend to interactive examples of wayfinding design such as the GPS-enabled WI.

An exception to this is Per Mollerup's recent *Wayfinding > Wayshowing* (2013). Here, Mollerup offers a brief overview of GPS-enabled WIs, with two basic types identified: 'general maps' (e.g. Google Maps) and 'location specific apps' (e.g. local tourist apps). In outlining their 'benefits' and 'burdens', Mollerup notes that while WIs offer portable, updatable information, and can transform the process of wayfinding into an 'entertaining game', they may also leave the user feeling 'locked to their smartphone, watching the phone more than the environment' (p.160). Regrettably, apart from identifying the issue, Mollerup does not explore this notion of the 'locked' user any further.

Similar issues have been identified within a number of recent studies attending to the use of GPS-enabled WIs. In some cases a series of recommendations to design practice are offered. In others, potential directions for future research are outlined. In seeking to further position this enquiry, we will now consider a number of these recommendations and directions.

Writing from the perspective of cognitive science, Willis et al. (2009) investigated different modes of 'information provision on spatial knowledge acquisition'. Here, one group of participants learned an environment from a standard, printed map and the other through the use of WIS presented on handheld mobile technology. From this, both groups were then asked to provide orientation and route-distance estimates in an external environment. Results showed that the first group, i.e. the users of the standard map, performed better. This led the team to make a number of recommendations to design practice. A key issue related to how the 'passive model of interaction' that WIS currently support does not appear to enable spatial knowledge acquisition. The authors also criticise conventional approaches to the 'map format' and suggest that it may be that these further exacerbate the issue.

> 'Maps are a fundamental example of how spatial information presented in an abstract manner fosters certain ways of acting in the world, which may have cognitive benefits but also drawbacks.'
> (Willis et al. 2009:109)

A recent study from Oksanen et al. (2014) also identified that the format of conventional topographic maps could be problematic for younger users. The team suggest that cartographic firms might look at developing more experimental approaches to map design to attract 'digital natives'.

Anticipating such issues, Tumasch Reichenbacher, suggests that 'ways of acting in the world' should direct the course of future research into what he terms 'geo-user interfaces' (2004:153). For Reichenbacher, this relates to 'how the user interface might be adapted according to mobile user actions, different user groups, [and] user roles'. Additionally he notes that research into the 'ontologies of "mobile user activities" has to be continued.' Here 'empirical research has to find mappings from typical activities to the most commonly used information types and presentations' (ibid).

From the perspective of mobile technology and map-use, computer scientist Barry Brown has conducted a number of ethnographic studies involving the observation of tourist behaviour in-situ. In one study, undertaken with Matthew Chalmers, it was concluded that 'map use is often less about explicit route planning and more about wandering through a city in a "roughly correct" manner'. For the pair, this wandering was 'more directional than specific' (2003:12). Accordingly, they recommend that GPS-WIS could: 'support more of the "wandering" behaviour of tourists' and 'show at a glance whether a tourist is going in the right direction rather than simply supporting a pre-determined route…' (Brown and Chalmers 2003:17).

Reflecting on the above, the following implications for the present research are identified. First, it has been shown that the passive models of interaction afforded by GPS-enabled WIS can impair users' spatial knowledge acquisition. This may be, to some extent, exacerbated by conventional approaches to the design of maps (Willis et al. 2009:109). Second, it has been argued that users' ways of acting in the world should be studied in order to find 'mappings' between information types and their 'presentations' (Reichenbacher 2004:153). Third, and finally, with the case of wandering urban tourists it may be that an interface design that affirms the user's direction 'at a glance', might offer a more appropriate form of support than standard representational approaches (Brown and Chalmers 2003).

This research, then, aligns with the above recommendations as they propose that attention be directed towards the apparent *imbalance* inherent in what we might term the user's *interface-environment relations* (i.e. the connections a user establishes between a digital interface and the surrounding environment). Herein, conventional design approaches are seen to negatively *distort* or *interfere* with the user's environmental experience.

This brings us finally to the concept of *situation awareness*, which we will now move on to consider. In doing so we will first look at how it has originally been presented within psychology literature and, from this, consider how it shall be appropriated within this enquiry.

2.3.7 The Wayfinding Urban Recreational Walker, Situation Awareness and GPS-enabled Technology

The psychological concept of situation awareness (SA) is seen to emerge in the 1980s within performance-related studies undertaken in complex, dynamic environments such as air traffic control and inflight navigation systems. (See Durso and Sethumadhavan 2008 for a review of SA approaches and applications). Within this domain, SA is formally defined as:

'the perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status into the near future' (Endsley 1988, here quoted from Endsley and Jones 2012:13). While it is acknowledged that work undertaken in this area is of immense value within its domain of application, this enquiry frames and defines the concept of SA somewhat differently.

Let us now consider this framing and definition in order that it may be distinguished. As was outlined above (see Section 2.3.1), within this enquiry, the walker's/wanderer's experience of the environment is seen as being grounded in their embodied involvement in that environment, i.e. their *situation*. Hence, it follows that walkers must perceive and comprehend their environment *through* embodied involvement within that environment. In taking this view, we may say that SA, therefore, would here refer to

a person's awareness of their embodied involvement in the surrounding environment.

It will be noted that the above definition does not make reference to either 'perception' or 'comprehension'. Both are seen as entwined in experience, and the concept of 'awareness', in turn, is seen to irreducibly enfold the two. Further to this, it will also be noted that the above definition is solely concerned with a person's awareness in the *present*, and not with their ability to project 'into the future'. As projection into the future appears to be essential to psychological understandings of SA, its absence in this enquiry's framing may be taken as the key distinguishing factor between the two.

Thus, having framed, defined and distinguished the concept of SA within this enquiry, it will helpful to now recapitulate the underlying thrust of this research.

We are seeking to understand how GPS-enabled WIs can be designed to support an urban recreational walker's/wanderer's *situation awareness in use* (SA-in-use). Thus, 'situation awareness' in the use of WIs while walking/wandering may be understood as the desired *user-experience* that we are looking to shape[6]. Based on the above definitions of SA and wayfinding (see Section 2.3.2), we are now in a position to set forth a statement in relation to how one might reasonably assert that an urban recreational walker's/wanderer's SA was supported in their use of a GPS-enabled WI. Accordingly, it is stated that such an urban recreational walker/wanderer would *remain aware of their embodied involvement in the surrounding environment, by continuing to apply embodied perception and embodied understanding in linking together and comprehending a series of seen vistas.*

This statement will be drawn upon later when we seek to establish whether or not SA-in-use was supported for participants in a prototype test (see Section 6.1.2). For now, with the above literature review complete, we will move to gather its various definitions together in a visual conceptual framework.

2.4 A Visual Conceptual Framework

From the above review, the following visual conceptual framework is presented.

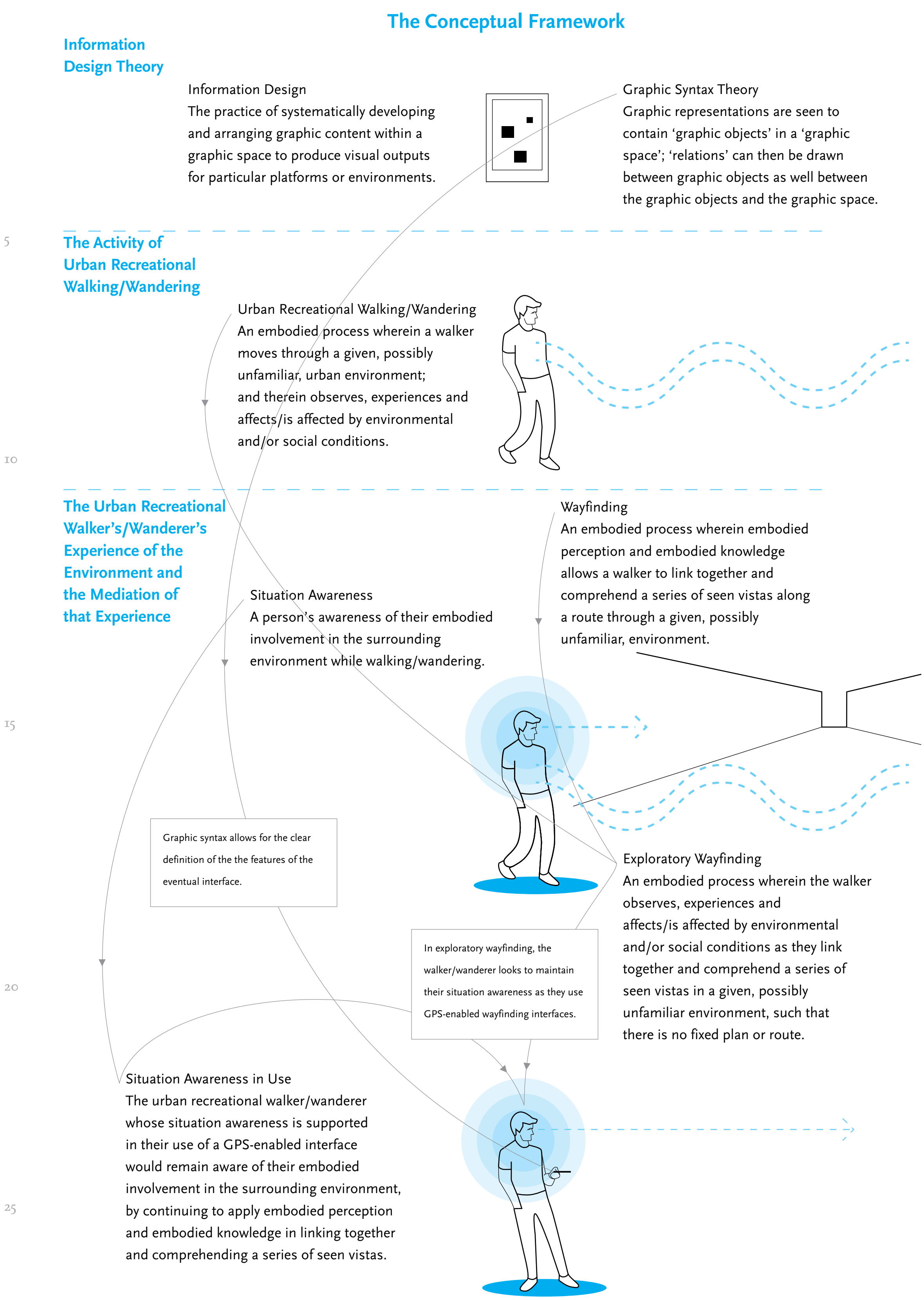


Fig.2.11 A visual conceptual framework. The framework incorporates three layers. First, the perspective taken within information design theory is identified. Then, the activity of urban recreational walking is defined. Finally on the third layer, we see that various concepts associated with the walker's experience of the environment are defined. Additionally, a statement relating to the support of situation awareness in use is offered.

From the above visual conceptual framework, we will now move on to the next chapter where we will look at the particular methodological stance that has been developed through the course of the enquiry, as well as detail its methods.

Summary

This chapter has presented the results of the present enquiry's literature review. It was divided into four sections.

In the first section the field of study was identified as information design. Then, alignment has been made with those theorists who take, what was here termed, a 'semiotic approach', focusing on the study of signs and their systematic application (e.g. Bertin 2011/1967). Through a review of various semiotically-informed theories, Yuri Engelhardt's graphic syntax theory (2002) was selected as a framework to allow for the systematic description of the *structure* of graphic representations produced within the enquiry.

Then, in the second section the historical emergence of the activity of urban recreational walking was briefly traced through the character of the flâneur. Thereafter, a series of theoretical linkages were drawn with work undertaken in the fields of sociology and human geography. These linkages allowed us to frame and define the activity as an embodied process, wherein the walker moves through and affects/is affected by the environmental and/or social conditions.

Next, in the third section the structure of the relations between the walker and their environment were considered, as well as the ways in which these relations are mediated by design and technology. In reviewing perspectives on wayfinding, alignment was made with those who identify with the ecological perspective, i.e. those who see wayfinding as an embodied process.

Thereafter, reviewing literature on wayfinding design, two critical theoretical gaps were noted. First, it appeared that little effort has been made to contextualise, and so *draw in* digital examples of wayfinding design. Second, it appeared that little work has been done exploring the arrangement of graphic content in graphic space to produce graphic representations for *specific* wayfinding use-contexts, such as urban recreational walking/wandering.

From this, a number of recent research recommendations concerning GPS-enabled WIS were highlighted. Here, alignment was drawn with a number of recommendations, which propose that attention be directed towards the apparent *imbalance* inherent in users' *interface-environment relations* (i.e. the connections a user establishes between a digital interface and the surrounding environment). Responding to this, the concept of SA was introduced and, for the purposes of this enquiry, framed and defined. Lastly, based on the literature review's preceding definitions, a statement was set forth in relation to how one might assert that an urban recreational walker's/wanderer's SA-in-use was supported.

Then, in the fourth and final section, through a synthesis of the review as a whole, a visual conceptual framework was presented.

Endnotes

1. In addition to this, the book's second part looks at the 'utilization' of the graphic sign system and so deals with the concerns, which may arise in the course of designing Bertin's honoured graphic formats: diagrams, networks and maps.
2. It is acknowledged that the same could be said of Bertin (2011/1967), however this is nuanced by the fact that Bertin's work has received much subsequent attention and development by later theorists (e.g. Richards 1984; MacEachren 1995; Engelhardt 2002; Blok 2005).
3. In addition to the above, with elementary graphic objects (e.g. symbols), two further types of correspondence may be observed rebus-based and metonymic. The former refers to instances where '(part of) the spoken word for what is shown *sounds* like (part of) the spoken word for what is meant' (p.99, italics in original). The latter arises in the instances where 'there is (or used to be) a relationship of physical involvement between what is shown and what is meant' (Engelhardt 2002:99).
4. Unsurprisingly, these attempts have led to a variety of terms being trialled within the literature. These include: 'context-aware topographic maps' (Nivala 2003), 'map-based location based services and telecartography' (Gartner and Uhlirtz 2001), 'cybercartography' (Fraser Taylor and Caquard 2006) and 'mobile cartography' (Reichenbacher 2004; Meng et al. 2005). Rather than marking out fundamentally divergent areas, this diversity is seen to reflect the relative newness of the research area. As the field gradually moves towards consensus, we notice some terms fading, marking only a moment in time (e.g. telecartography), while others are increasingly applied (e.g. mobile cartography). In what follows we will continue to refer to all such projects as GPS-enabled wayfinding interfaces.
5. Here, a link may be drawn with Engelhardt's notion that a pictorial object may range from realistic through to schematic (see Section 2.1.5.2).
6. It should be noted that this identification of a desired user experience originally took place through an analysis of the data collected in the programme of semi-structured interviews, undertaken alongside this literature review. This process of identification is described in Section 4.3.

3. Methodology

Having outlined the literature with which this research identifies in the last chapter's review, we will now move on to provide an overview of the enquiry's methodological stance, as well as its methods. It is important to note that what follows has been written 'post-hoc', i.e. after the event. Therefore, at certain points it has been found necessary to detail—in real terms—specific choices that have been made. It will be observed that these portions of the text have been isolated from the main body and a reduced text size has been applied. This so as to draw attention to their separate character.

The chapter is made up of three sections. In first section we will consider the particulars of the research strategy, as well as the theoretical perspective of pragmatism, which is seen to underpin the enquiry. In the second section we will deal with issues relating to the programme of semi-structured interviews and the analysis of data therein. Finally, in the third section, the application of design practice within a series of experiments will be described, along with the process of graphic syntax definition and contextualisation.

3.1 Research Strategy

Within this enquiry, a research strategy (Robson 2011) involving two separate phases has been applied. In the first phase, a programme of semi-structured interviews provided material against which an area for experimentation could be framed and, from this, a design hypothesis formulated. Herein, an exclusively *qualitative* method of data collection and analysis was applied. Then, in the second phase, a series of design experiments were conducted in order to develop a novel wayfinding interface (WI) in response to the design hypothesis. During this phase, both qualitative *and* quantitative methods were applied. Consequently, the enquiry may be seen to have pursued a 'mixed methods' approach. This approach was developed in response to the immediate requirements of the research, which has followed the research through design paradigm (Frayling 1993).

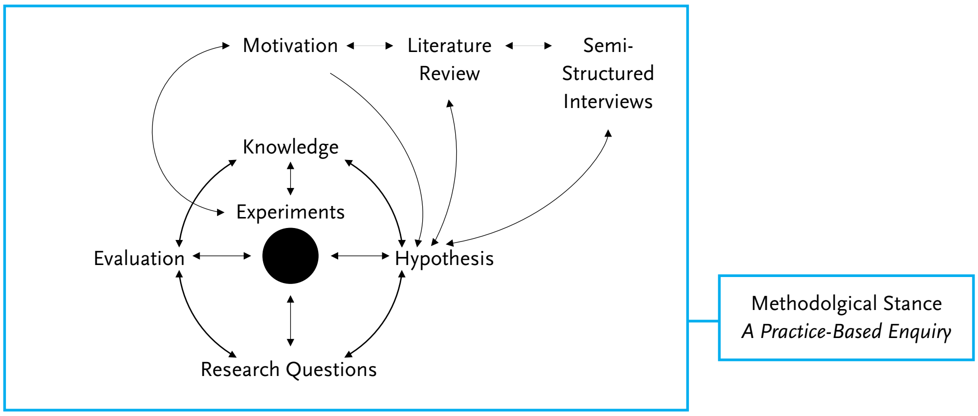


Fig. 3.1 The enquiry's methodological stance seen to enframe the whole of the diagrammatic overview of the enquiry.

3.1.1 *Practice-Based Enquiry as a Methodological Stance*

The 'research *through* design' paradigm, was initially proposed by Sir Christopher Frayling (1993:5, italics added). Here, *design practice* is seen as central to the *conduct of research*, such that the enquiry as a whole may be referred to as *practice-based* (Candy 2006). The incorporation of design practice within the conduct of research is seen to result in a fundamentally different form of knowledge production, which is distinct from that presented by the natural sciences. For Nigel Cross, this distinction is supported by what he refers to as 'designerly ways of knowing' (2007). Differentiating between design and science, he notes that:

> 'Designing is a process of pattern synthesis, rather than pattern recognition. The solution is not simply lying there among the data, like the dog among the spots in the well known perceptual puzzle; it is actively constructed by the designer's own efforts.'
> (Cross 2007:24).

With a focus on *construction* as opposed to *discovery*, a practice-based enquiry becomes a form of research on what *could be* as opposed to what is (Steen 2011:48). In order to begin to consider what could be, the view is taken that experimentation is necessary. Thus, as has been pointed out in the Preface, the present enquiry *centralises* the *design* experiment in the research. In addition to this, it positions the hypothesis as a *productive device*, which enables the process. Thus, it is *through* the hypothesis that 'knowledge, empirical findings, concepts and ideas' are combined in the creation of 'abstract prototypes to be tested and debated' (Bang et al. 2012:7).

Such a framing is found to mirror John Dewey's notion of 'experimental empiricism' (1984/1929:90). Here, Dewey argues that 'experimental thinking' is 'not random aimless action', but involves 'deliberate foresight and intent' (ibid:88-89). Here again, the hypothesis is positioned as a productive device, which enables the process. Hypotheses, for Dewey, may be seen to:

> '...open up new points of view; [and] liberate us from the bondage of habit which is always closing in on us, restricting our vision both of what is and of what the actual may become. They reveal new truths and possibilities.'
>
> (ibid:247)

Pursuing this perspective more fully in later writing, Dewey set out his vision of the 'pattern of inquiry' (Dewey 1986/1938). Here, as a starting point, emphasis is placed on the notion that an individual must *conceive* of a situation as being 'open' to an enquiry on the basis that it is 'indeterminate' and so 'questionable'. From this, various stages are passed through, with each marking a particular moment of progress. Included amongst these stages we find: 'the institution of a problem', the 'determination of a problem-solution', and a period of 'reasoning' (Dewey 1986/1938:111-115). The end of an enquiry is arrived at in 'the institution of conditions which remove the need for doubt' (ibid:15).

Seeking to provide a definition, which encapsulates the above, Dewey offers the following:

> 'Inquiry is the controlled or directed transformation of an indeterminate situation into one that is so determinate in its constituent distinctions and relations as to convert the elements of the original situation into a unified whole.'
>
> (ibid:108)

From this, it will be helpful to briefly consider how Dewey's definition may inform the present enquiry. As has been stated, we are here focusing on the design of GPS-enabled WIS for urban recreational walkers/wanderers through the inclusion of design practice within the conduct of research. Thus, through the act of *designing* we are seeking to transform our 'indeterminate situation' into one which is determinate. Accordingly, in order that a determinate situation be arrived at, and the elements of the original situation be 'converted' into a 'unified whole', it is deemed necessary that a design artefact be included as part of any outcome. Thus, an *artefactual* contribution to knowledge is made as part of a broader suite of contributions; the particularity of which we will now consider.

3.1.2 *Practice-Based Contributions to Knowledge*

Discussions relating to the form that practice-based contributions to knowledge may take have resulted in much debate. Bruce Archer states that, despite the context-specific form of such research, it 'can advance practice and can provide material for the conduct of later more generalisable, studies'. He goes on to insist that this can only be the case if 'the research is methodically sound, the qualifications are clearly stated and the record is complete' (1995:11). Taking a similar view, William Gaver (2012) discounts the possibility that practice-based research may result in theories which carry a high degree of falsifiability (i.e. that can be easily refuted), which Karl Popper claimed to be the measure of good science (1959). Rather, Gaver suggests that an alignment be made with those who highlight the 'generative' potential of theory in science. On this view, design researchers are seeking to formulate theories which are 'sometimes right' (Gaver 2012:941). Here, artefacts become 'the definite facts of research through design', while an accompanying non-generalisable theory would make 'accessible the kinds of decisions and rationales that comprise an artefact's embodied theory' and so act as a form of 'annotation and inspiration' (p.944).

John Zimmerman and colleagues (2010) take a similar but somewhat more generous stance. On their view, practice-based research may result in two forms of theoretical contribution: theory *for* design and, possibly, theory *about* design (p.313). Theory for design can take several forms, including: conceptual frameworks, guiding philosophies and 'implications' for design. These can then be offered to a community of designers and/or researchers, who may choose to accept or reject the contribution.

In this enquiry, we blend Zimmerman et al.'s position with that put forward by Gaver. Thus, an original artefact is produced as a *practical response* to the first research question (see Section 1.1). From this artefact, a contextualised *graphic syntax* (Engelhardt 2002) is generated. This contextualised graphic syntax acts an *annotation* to the artefact and, through a set of principles, provides an outline for the design of a GPS-enabled WI. Thus, it is unlike a generalised design pattern (Alexander et al. 1977), which arises from the observation of *multiple* effective design structures. Rather, it is generated from a *single* effective design and so is seen to offer a non-generalisable set of principles, which may guide/inform future designs.

Further to the above, in the definition of the artefact's graphic syntax the applicability of Engelhardt's graphic syntax theory (2002) to dynamic and interactive graphic representations is considered. From this, an extension of the analytic framework is proposed. Here, by expanding the framework's scope, the description of the dynamic and interactive aspects of graphic representations is made possible.

As a means of the grounding the above and pointing towards an appropriate set of evaluation criteria, this research takes the philosophy of pragmatism as a theoretical perspective.

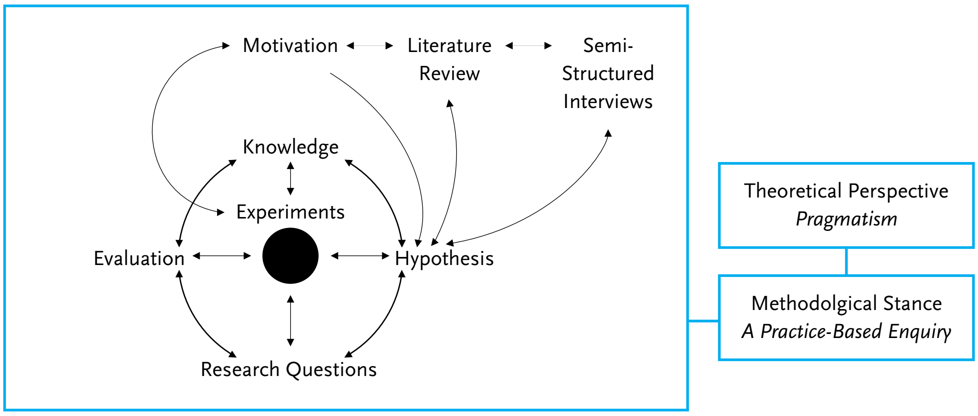


Fig. 3.2 The enquiry's theoretical perspective of pragmatism is seen to link to its methodological stance, i.e. practice-based enquiry. Here, the arguments put forth by pragmatism are seen to legitimise the notion that knowing and doing are intertwined.

3.1.3 *Pragmatism as a Theoretical Perspective*

According to Crotty (1998:3) a theoretical perspective *informs* a methodological stance and, so, provides 'a context for the process', at the same time as 'grounding its logic and criteria'. Thus, as has already been indicated through reference to the work of John Dewey, this enquiry takes the philosophy of pragmatism as its guiding theoretical perspective.

Along with Dewey, 'classical' pragmatism is closely associated with the work of two other American philosophers: Charles Sanders Peirce[1] and William James (Bernstein 2010).

While each may be seen as having cultivated a perspective which is more or less their own, a number of parallels and shared values can be identified across the group. These parallels and values are here judged to hold particular relevance to the undertaking of a practice-based enquiry. While some theorists have begun to articulate the possible contributions of pragmatism (e.g. Dalsgaard 2009; McCarthy and Wright 2004; Jonas 2007), it will be instructive to here briefly consider the ways in which the perspective may inform a practice-based enquiry.

To begin, a key contribution of pragmatism is the flexibility it affords in relation to the application or adoption of theories within the research process. Here, James tells us that pragmatism 'unstiffens all our theories, limbers them up and sets them to work'. Ultimately, he argues, theories must be seen as 'instruments, not answers to enigmas, in which we can rest' (James 2012/1907:27). This openness is seen to allow for the adoption of a mixed methods approach without undue concern being given to the philosophical implications (Robson 2011:171).

From this, another contribution is identified in pragmatism's recognition and, indeed, celebration of the generative aspects of enquiry. We see this in Dewey's consideration of a hypothesis (see Section 3.1.1 above). We also see it in the concept of abduction, a form of reasoning first proposed by Charles Sanders Peirce (see Peirce 1998/1903:241-266). Unlike, the more conventional forms of reasoning, i.e. induction and deduction, abduction allows the researcher to engage in a course of relatively unconstrained imaginative *conjecture* or *projection*. As Peirce put it:

> '[Abduction] allows any flight of imagination, provided this imagination ultimately alights upon a possible practical effect...'
>
> (Peirce 1998/1905:235)

Based on the above outline, many theorists have noted how abduction may be seen to bare faithful resemblance to the types of reasoning commonly applied by designers (e.g. Steen 2013; Dorst 2011; Cross 2007; Roozenburg 1993; March 1976).

This leads us to a further contribution relating to our understanding of the relationship between knowledge and experience or, more specifically, between thinking and action. Here, Dewey argues that *reflective* thought or 'thought that involves inference or judgement' is not a random exercise. Rather it connects with 'immediate knowledge' of the world and, as such, is unavoidably tested in experience (1984/1929:88). Thinking then becomes 'the accurate and deliberate instituting of connections between what is done and its consequences' (Dewey 1981/1916:505). Key, here, is the belief that knowing and doing are not separate activities but, instead, should be seen as an entwined process. Consequently, what Dewey called the 'spectator theory of knowledge', i.e. the view that knowledge can be issued *apart* from circumstance, is undermined (Baert 2005:152). In this way, practice-based enquiry finds its legitimacy.

Finally, pragmatism also contributes by providing a useful account of truth. On this matter, it is James who is perhaps the most forthright and daring. According to him, a pragmatist, in referring to truth, would take the view that:

> 'Any idea upon which we can ride, so to speak, any idea that can carry us prosperously from any one part of our experience to any other part, linking things satisfactorily, working securely, simplifying saving labour; is true for just so much, true in so far forth, true INSTRUMENTALLY.'
>
> (James 2012/1907:29, capitals in original)

Such a view is especially appealing when considered next to Nigel Cross's position in relation to design problems. Cross claims that because the 'necessary information is not, or ever can be, available' such problems are 'not susceptible to exhaustive analysis'. Consequently, 'there can never be a guarantee that "correct" solutions can be found' (Cross 2007:23-24). It follows that, when *designing* within a practice-based enquiry, we must seek to achieve that which may be judged to be 'true instrumentally', i.e. we must seek to demonstrate that something 'works'.

Continuing to interrogate the concept of truth, James goes on to emphasise that truth is something which *occurs*, i.e. it is a process, rather than something that 'is' outright.

> 'The truth of an idea is not a stagnant property inherent in it. Truth HAPPENS to an idea. It BECOMES true, is MADE true by events. Its verity is in fact an event, a process: the process namely of its verifying itself, its veri-FICATION.'
>
> (James 2012/1907:84, capitals in original)

Peirce, like James, also deals with truth. On his account, truth—or as he would have it 'the real'—is that 'which sooner or later, information and reasoning would finally result in, and which is therefore independent of the vagaries of you and me' (Peirce 1992/1878:52). Through this mention of the 'vagaries of you and me', Peirce hints at the ultimate fallibility of all individually issued knowledge claims. Yet at the same time, his positioning of the truth as something which is 'sooner or later' arrived at through 'information and reasoning', also provides us with a conceptual means of avoiding the pitfalls of traditional epistemological scepticism, i.e. the belief that 'real' knowledge is impossible (Bernstein 2010:37).

Dewey claimed to be impressed by Peirce's definition of truth (Dewey 1986/1938:17). However, in setting out his pattern of enquiry, he does not give the concept very much consideration. Instead, he takes issue with what he sees as the ambiguity found in the related concepts of *belief* and *knowledge*. By way of alternative, he proposes the term 'warranted assertibility' be applied to the claims that allow an enquiry to mark its logical conclusion (ibid:16). Following this view, it is the quality and the competency of the internal framing of the enquiry which must be seen to withstand judgement, as opposed to any supposed correspondence to an ultimate, objective reality.

Having set out the above, it now appropriate to give consideration to the type of evaluation criteria to be applied within the present enquiry.

3.1.4 *Evaluation Criteria*

Conventionally, research is evaluated based on its reliability, replication, and validity (Bryman 2008:46). On occasion, objectivity may also be included (Lincoln and Guba 1985:391). These terms each designate a particular criterion, which must be demonstrated before any results are to be accepted.

Here, reliability refers to whether or not the research instruments have been shown to produce consistent measurements. Replication is directly related reliability; it refers to whether or not the original results have been repeated. Validity, seen as the most important criterion, refers whether or not the research may be seen as internally, externally, and ecologically (i.e. contextually) sound (Bryman 2008; Robson 2011).

There has been much debate in regard to the applicability of such criteria to qualitative research. In particular, given the dynamic and complex character of social life, the possibility that qualitative research might be replicated is seen as dubious. Yet, despite the apparent incompatibility of conventional criteria to qualitative research, the general position taken is that such research should not seek to diverge from these agreed standards (e.g. Morse 1999). Instead, it is often recommended that those engaged in qualitative research adapt the above terms to better suit their own approach (e.g. LeCompte and Goetz 1982; Kirk and Miller 1986).

The present enquiry however does not conform to this position. Instead, the view is taken that if the definition and meaning of each criterion must be altered such that it diverges markedly from the conventional form, it would be preferable to differentiate one's approach rather than feign compatibility. Moreover, given pragmatism's particular treatment of knowledge (i.e. as arising out of practices) and truth (i.e. by shifting the focus to 'warranted assertibility'), an alternative set of criteria is seen as desirable. Thus, the concepts of credibility, transferability, dependability and confirmability are selected.

3.1.4.1 *Credibility, Transferability, Dependability and Confirmability*

Taken together, credibility, transferability, dependability and confirmability provide a set of criteria with which to evaluate what Yvonna Lincoln and Egon Guba (1985) refer to as an enquiry's *trustworthiness*. Each is seen to parallel a criterion within the conventional set:

> Credibility, parallels internal validity;
> Transferability, parallels external validity;
> Dependability, parallels reliability;
> Confirmability, parallels objectivity.
> (Bryman 2008:391)

We will now consider each criterion in turn and, alongside this, set out the ways in which it has been met within the present enquiry.

Firstly, with regard to credibility, the researcher is required to demonstrate two things: that the enquiry has been carried out in such a way as to ensure that its results may be deemed *credible*; and that these results have been 'approved' by its members (i.e. its participants) (Lincoln and Guba 1985:296).

Consequently, within this enquiry a number of techniques have been used in order to ensure the results may be deemed credible, including:

- triangulation;
- negative case analysis;
- and referential adequacy.

Triangulation refers to use of multiple methods of data collection and analysis. Here, in the second research phase, two methods of data collection and analysis have been applied in order that the phenomenon of interest (i.e. situation awareness in use) may be more fully understood.

Negative case analysis requires that cases which do not conform to the emergent consensus be examined and, so far as is possible, understood (Lincoln and Guba 1985:309). Thus, cases that did not 'fit' underwent further analysis in order that the particularity of their divergence be explored (see Sections 4.3 and 6.1.2.1 for such explorations).

Referential adequacy requires that equipment be used in the *recording* of the research situations, so that the data might be subsequently accessed and considered by others (ibid:313). Thus, all interviews and tests have been digitally recorded and are made available for the perusal of others who wish to scrutinise or consult the original material (see Appendix J). Additionally, at certain critical points, fragments of raw data (i.e. participants' direct contributions) have been included within the main document. This allows for close examination of the researcher's reasoning and analytic decisions.

Beyond these techniques, in order to further demonstrate credibility, where possible, member checking has taken place. This has generally been an informal activity, wherein the researcher sought to establish the appropriateness of particular framings in particular cases. However, on a number of occasions, annotated interview transcripts and the results of analysis have been formally presented to participants for their consideration. Further, during the generation of the contextualised graphic syntax, a formal member checking process took place. This involved a sample of participants being presented with the emergent results of the prototype test and invited to respond (see Appendix H).

Following on from credibility, in regard to the next criterion—*transferability*—Lincoln and Guba recommend that the researcher should seek to provide a 'thick description' (Geertz 1973) of their process. It is intended that such a description may act as a 'data base' enabling other researchers to apply a similar/related approach in an alternative context (Lincoln and Guba 1985:316). Thus, a judgment must be made on the extent to which this document may be seen to provide a thick description.

Then, with regard to the criterion of *dependability*, the researcher is expected to provide an *audit trail* so that the enquiry's raw data and analytic procedure may be scrutinized. This is here enabled through the provision of an audit trail map (see Appendix I). The map aims to offer an overview of the research process from the collection of raw data (i.e. audio/video recordings) through to the results of analysis. Thus, all of the raw data files, analysed transcripts and observation notes are submitted alongside the thesis proper (see Appendix J).

This leads us to the final criterion of *confirmability*. In Lincoln and Guba's proposal that this term replace objectivity, a parallel emerges with Dewey's concept of 'warranted assertibility' (see section 3.1.4 above). Here, in rejecting 'objectivity', we must accede that many interpretations of the 'real' are possible. Again, what matters is our *dependability*, i.e. the transparency and accessibility of our process. Accordingly, this enquiry's *confirmability* is seen to rest on the strength of its audit trail.

We have now covered the dimensions of the enquiry's research strategy in full and so will turn to consider the particulars of its methods; beginning with the programme of semi-structured interviews.

3.2 Semi-Structured Interviews

In order to begin to gain an understanding of how the activity of urban recreational walking/wandering was approached and practiced, the technique of semi-structured interviews was selected. This selection was made on the basis that it allows researchers to remain flexible in their approach to each interview and so pursue unexpected lines of conversation (Bryman 2008:472; Robson 2011:285). In order to begin, it was necessary to first identify and recruit participants. This required that a sampling strategy be devised.

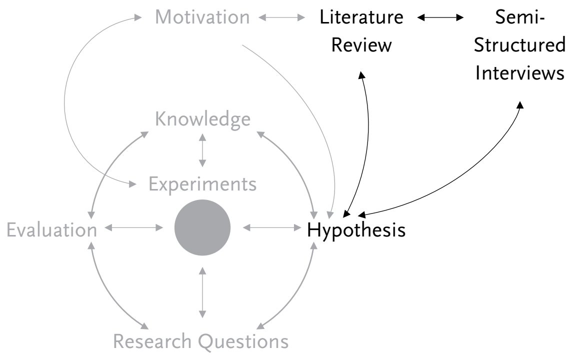


Fig. 3.3 The semi-structured interviews are seen to link to the enquiry's literature review and help inform its hypothesis.

3.2.1 *Identifying Urban Recreational Walkers/Wanderers: Recruitment and Sampling Strategies*

Through a tentative literature review and the development of a primitive conceptual framework, it was possible to frame an early set of desirable characteristics to be applied within participant recruitment. Here, it was seen as desirable that participants would have:

- experience of the activity of urban recreational walking/wandering;
- and experience of the practice of exploratory wayfinding (see Section 2.3.2.1) within urban recreational walking/wandering.

This allowed a small, initial group of participants to be recruited on the basis of personal recommendations, as well as through the issuing of a request among a student cohort. Here, we may say that a *purposive* sampling strategy was applied, i.e. individuals who could offer an in-depth insight into the activity of urban recreational walking/wandering were favoured and selected for inclusion. From this, further recruitment was undertaken via social media, wherein potential participants were identified through their online profile. Here again, the same set of desirable characteristics was applied.

However it became apparent that an explicit interest in wandering was crucial in order that insight into exploratory wayfinding within urban recreational walking/wandering be properly grounded.

While interviewing the initial group of participants, a technique known as *snowball sampling* (Browne 2005) was also applied in parallel with the overall purposive sampling strategy. Here, participants from the original core group were asked to suggest, and in some cases voluntarily offered, the details of other potential participants. Thus, a participant network was established.

Through this embedding of one complimentary sampling strategy within another we may say that the enquiry's *overall* sampling strategy was 'sequential' (Bryman 2008:418). That is, it has followed a progressive path, which was not 'fixed', but rather *evolved* as the research advanced.

Alongside the initial recruitment, an interview guide was developed.

3.2.2 *The Interview Guide*

The development of an interview guide (Bryman 2008:471), i.e. the framing of the list of topics to be addressed within the interviews, was informed by the first two research aims. Thus, two general lines of questioning were established: firstly, in relation to participants' approaches to and practice of urban recreational walking/wandering; secondly, in relation to how GPS-enabled WIs are currently used and perceived by urban recreational walkers/wanderers. Additionally, within these, further specificity was guided by the same tentative literature review and primitive conceptual framework that enabled participant identification (see section 3.3.1 above).

Following a standard interview structure, three distinct stages were envisioned: a *warm-up*, a *body*, and a *close* (Robson 2011:284). In the interview's opening stage, it was reasoned that a number of simple questions relating to the practice of urban recreational walking/wandering would allow the participant to adjust to the interview process. Thereafter, in the interview's body, key topics such as the *experience* of urban recreational walking/wandering and GPS-enabled technology-use would be addressed. Finally, in order to signal the interview's close, a wind-down question relating to the affect of maps and map-use was included. From this, a list of topics was developed and arranged in the following order:

- The level of frequency claimed by participants in relation to urban recreational walking/wandering;
- Participants' motivations to walk/wander;
- Participants' exploratory wayfinding practices;
- The wayfinding resources they drew upon while walking/wandering, including their preferred map features;
- Their use of GPS-enabled WIS;
- The positives and deficits of GPS-enabled WI use;
- General stance in relation to the affect of maps and map-use.

This list acted as an outline for the interview guide's sequence. As a next step, *specific* questions were formulated.

3.2.3 *The Formulation of Questions*

Through three *pilot* interviews, an early set of questions relating to the topics set out above (see section 3.3.2) were tested and iterated until a satisfactory level of refinement was achieved.

Above all, these pilot interviews provided an opportunity to develop a suitable participant-centred vocabulary. Thus, when particular terms or phrases were found to require further explanation, they were flagged as problematic and were subsequently adapted.

> For example, in order to gain a clear understanding of how exploratory wayfinding was practiced within urban walking/wandering a number of terms were trialled, e.g. 'exploratory walking'. However, due to participants' lack of familiarity with such examples, it became necessary to refer to 'walking without fixed plans or routes in mind' for the sake of transparency. This ensured that participants were provided with a simple definition with which to examine their own experiences.

Further to the above, the most appropriate *kinds* of questions were also considered (Bryman 2008; Smith et al. 2009). Here, as the interview moved from the opening to the body, a series of what Bryman terms 'introducing' questions were lined up (2008:476). It was intended that, in answering, participants would only be required to provide relatively short, straightforward responses. Following on from this, in order to define the body of the interview, a number of more 'open' questions were formulated. For the most part, these resembled what Smith et al. (2009) refer to as 'descriptive' and 'structural' questions (p.60). Here, extensive, in-depth responses were sought (i.e. open descriptions or structural-accounts) so that the particulars of urban recreational walking/wandering practices and GPS-enabled WI use might be identified. Then, two final 'evaluative' questions (Smith et al. 2009:60) brought the interview to a close. The first of these related specifically to participants' experience of GPS-enabled WI use. Responses to this question were held to be particularly significant, as it was intended that the data would provide material against which an area for experimentation might be framed (see Section 3.2.7).

In the end, the guide's original, broad focus was maintained so that it might yield a *rich, wide-ranging* dataset. This resulted in a final list of eighteen questions (see Appendix A for the full set of questions). With these to hand, it was possible to arrange and conduct the first set of interviews.

3.2.4 *Arranging, Conducting and Documenting Interviews*

In the early stages of recruitment, participants were accessed through a series of recommendations. Accordingly, these interviews were arranged on a casual basis. However, as the programme progressed and other, more extensive recruitment techniques were applied, it became necessary to make more formal arrangements. Here, in order to maximise the participant's sense of comfort and control, each individual was invited to specify *where* and *when* the interview might take place. As a result of this strategy, interviews were often conducted in cafes and pubs, either during the afternoon or else the early evening. Additionally, due to their geographic distribution (e.g. residing in North America), it was necessary to interview a number of participants over Skype.

As recommended by Smith et al. (2009:64), a special effort was made early on in the interview to establish a rapport with the participant. If time allowed, a relaxed discussion was entered into prior to any questions being asked. In each case, the participant was offered an introduction to the present research, as well as its intended outcomes. Once it became clear that they were comfortable, the interview would commence.

Every interview was digitally recorded in full, thus ensuring the later availability of this data and, as such, strengthening the enquiry's overall *credibility* by guaranteeing referential adequacy (see section 3.1.4.1 above, and Appendices I and J). Most interviews lasted in the region of 30 minutes; the shortest was 20 minutes and the longest 1 hour and 15 minutes.

In order to allow for analysis, each recording was at least partially transcribed, with all transcription being carried out solely by the researcher. Though time-consuming (documents ranged up to 8,500 words in length), this allowed for the development of a familiarity or 'intimacy' with the data (Etherington 2004:79).

From transcription, a formal analysis of the data commenced.

3.2.5 *Interpretive Phenomenological Analysis*

Throughout this research, within both the programme of semi-structured interviews and the subsequent design experiments, the process of qualitative analysis was guided by an 'interpretive phenomenology' and, so, was referred to as *interpretative phenomenological analysis* (IPA).

In IPA, inspiration is drawn from Martin Heidegger's incorporation and framing of hermeneutics (i.e. the study of meaning) within phenomenology (Heidegger 2010/1926). For Heidegger, phenomenology is concerned both with examining that which is 'latent, or disguised' but also that which is 'manifest' (Smith et al. 2009:24) in things and experience.

In applying IPA, the researcher aims to *interpret* how participants make *sense* of their *own* experience. As such, it may be seen to involve what is termed a 'double hermeneutic' (ibid:39). That is to say, it recognises two interpretation cycles: the participant's and the researcher's. Within the latter (i.e. the researcher's cycle), an *empathic* hermeneutics (i.e. a stance wherein one seeks to understand) is seen to be combined with a *questioning* hermeneutics (i.e. a stance wherein one seeks to be critical) (Smith et al. 2008:53).

Though IPA is not explicitly connected with the pragmatist tradition (i.e. the theoretical perspective guiding this enquiry; see section 3.1.3) the view is taken that phenomenology advanced in this way, aligns well with pragmatism. Indeed, Peirce directly links a version of phenomenology to his pragmatism[2] (Peirce 1998/1903:145-159). Thus, the technique of IPA was seen to provide the researcher with a clear, compatible, and reasonably well-established procedure.

In applying IPA within this enquiry, analysis was initiated through the reading of transcript texts, wherein the progressive annotation of the text was initiated. In common with thematic analysis (Bryman 2008:578) this process of annotation transformed into a coding, which allowed for the development of themes. As similarities emerged across the transcripts these themes were cyclically expanded and refined. At this point, the technique of subsumption was applied, whereby categories that bore reasonable resemblance were combined as one (Smith et al. 2009:97). Once the basic themes were in place, it was then possible to identify broader, organising themes, which allowed for the general grouping of the data. Throughout this process, by storing all related data fragments in separate files, a basic link was maintained between the quotations and the themes; that is, between a *statement* and its *interpreted* meaning.

The final process of analysis was directed toward the responses to eight key questions (see Appendix A for the full interview guide). These questions were:

Q.2: What motivates you to walk?

Q.8: Do you walk without a fixed route or plan in mind?

Q.9: If yes, can you describe the experience [of walking without a fixed plan or route in mind]?

Q.10: When you are in an unfamiliar location what resources do you usually draw on in order to find your way as you walk?

Q.11: Thinking specifically of (city) maps, what features do you find most useful as you walk?

Q.15: If [you use mobile maps] can you please describe how you use them?

Q.16: What are the positives and negatives of mobile map use?

The above questions were selected, based on their perceived usefulness as sources from which to identify the ways urban recreational walking/wandering was approached and practiced, as well as how GPS-enabled WIS were used and negatively perceived therein.

As mentioned above, Q.16 in particular was positioned as a source of data against which an area for experimentation might be framed (see Section 3.2.7).

In order to progress the analysis, it was necessary to gain an overview of the results. Thus, a series of mappings, gathering the basic themes, were compiled.

3.2.6 *Mapping in Analysis: Saturation and Further Analysis*

In arranging the result of analysis within a series of mappings, the aim was to 'capture the features inherent' within the particular 'body of information' that had been attained (Sullivan 2005:199).

> A single consistent format was applied in order to map the responses to each question. Here, themes were presented along a single row and then, through a connecting line, linked to another row of numbered participants. Accordingly, each theme was linked directly to the participants whose statements had led to its conception.

Mapping the data was seen to deliver two distinct benefits. On the one hand it ensured that saturation might be credibly demonstrated (Lincoln and Guba 1985; see Appendix B). On the other hand, it also allowed for further analysis to take place.

In further analysis, the researcher sought to introduce a *critical* perspective within their application of IPA by slowly exploring the mappings and asking: 'what is the emergent phenomenon?' Here, focus was directed towards the dominant themes, i.e. those themes which were connected to a large number of participants. This, in turn, allowed an area for experimentation to be framed.

3.2.7 *Framing an Area for Experimentation*

For Dewey, framing an area for experimentation—or as he would have it, 'the institution of a problem'—is presented as a pivotal stage within the course of an enquiry (see section 3.1.2). In outlining this stage, Dewey states that:

> 'The way in which the problem is conceived decides what specific suggestions are entertained and which are dismissed; what data are selected and which are rejected; it is the criterion for relevancy and irrelevancy of hypotheses and conceptual structures.' (Dewey 1981:229)

Taking this into account, the researcher sought to exercise care as they set about framing an area for experimentation. As a first step, a number of mappings of the data were combined in order to gain a deeper appreciation of the relationships between specific sets of results.

> Here, after trialling various combinations, two final mappings were produced which linked individual participants' motivations, to their use of GPS-enabled WIs and, lastly, to the perceived deficits of the technology. The first displayed only intrinsic motivations. The second displayed extrinsic motivations (see Section 4.2.1). This particular arrangement was seen to provide an insight into the situation from two distinct perspectives (i.e. participants' particular type of motivations and the use(s) associated with these), as well as to the issues emerging therein (i.e. the perceived deficits).

With such an overview to hand, the researcher set about the process of framing an area for experimentation. This notion of framing has been widely discussed in literature on design practice (e.g. Dorst and Cross 2001; Cross 2007; Lawson 2006/1980; Dorst 2006; Dorst 1995; Schön 1983). While there is little consensus regarding its inner-structure it would appear that, in attending to a problematic situation, designers commonly employ a 'solution-focused strategy' (Lawson 2006/1980:43). It has been argued that this may require a 'creative redefinition of [the] situation' (Dorst 2006:14), such that a solution is *anticipated* within the redefinition.

In this enquiry, analysis and comparison of the final mappings allowed the researcher to devise a *statement* in relation to the design of GPS-enabled WIs for urban recreational walkers/wanderers. This statement, in turn, enabled the formulation of a *design hypothesis*, i.e. the *outlining* of a possible solution. With such a hypothesis formulated, it was possible to launch the second phase of the enquiry.

3.3 The Design Experiments

In the second phase of the enquiry, a series of design experiments were undertaken. Herein, through the application of design practice, the researcher sought to develop a novel WI in response to the design hypothesis of the first phase. In order to initiate this process it was necessary to first establish a conceptual framework.

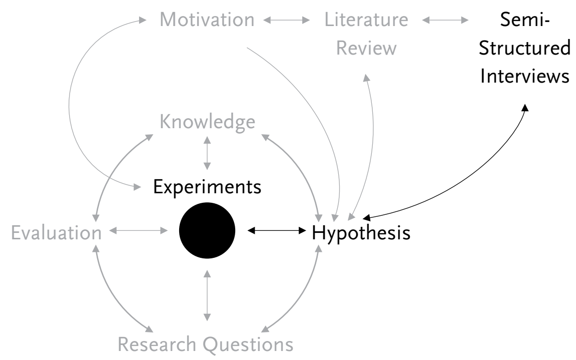


Fig. 3.4 Having framed an area for experimentation, it was then possible to formulate a design hypothesis, which in turn leads us into the experiment cycle.

3.3.1 *Developing a Conceptual Framework*

Concurrent with the programme of semi-structured interviews, a comprehensive literature review was undertaken. Herein, consideration was given to the enquiry's initial areas of focus (i.e. information design, urban recreational walking/wandering and GPS-enabled WIS), as well as the themes emerging from within the analysis of the interview data. In this way, a clear grasp of how numerous bodies of literature dealt with these areas and themes was obtained.

On completion of both the semi-structured interviews and the literature review, it was possible to develop a *conceptual framework*. Following Miles and Huberman (1994), it was intended that such a framework would allow the researcher to set clear boundaries within the second phase of the research. Outlining the possibilities of conceptual frameworks, the pair state that:

> 'A conceptual framework explains, either graphically or in narrative form, the main things to be studied—the key factors, constructs, or variables—and the presumed relationships among them. Frameworks can be rudimentary or elaborate, theory-driven or commonsensical, descriptive or causal.' (Miles and Huberman 1994:18)

Drawing inspiration from the above, a visual conceptual framework comprised of both graphic and textual forms, was presented (see Section 2.4). It was intended that this framework might function as a device, which gathered and related definitions of the enquiry's key concepts (i.e. its constructs). In the main, these definitions were theory-driven, i.e. they emerged from within the literature review.

Having developed definitions of the enquiry's key concepts, it was possible for the researcher to set forth a statement in relation to how one might reasonably assert that situation awareness in use (SA-in-use) was supported.

The availability of this statement ensured that both the qualitative and quantitative aspects of the second phase of the research were approached in a coherent manner. Accordingly, the later integration of both sets of results was supported.

From integration, it was intended that an assessment of participants' SA-in-use would take place. Thereby allowing for the verification of the design hypothesis.

Having developed the enquiry's conceptual framework, a test site for experimentation was selected.

3.3.2 *Selecting a Test Site*

In selecting a test site, the city of Glasgow—in particular its centre and west end—was seen as the most sensible option for two reasons. First, it was the researcher's city of residence, thus allowing for frequent, convenient access to both the test-site and potential participants. Second, the city's medium-size and architecturally varied centre made it an attractive setting for which to design a GPS-enabled WI.

Having made this selection, as a next step, it was necessary to consider the recruitment of participants.

3.3.3 *Recruiting Participants within the Design Experiments*

As within the programme of semi-structured interviews sampling within the design experiments was initially purposive, i.e. individuals who might be likely to engage in the activity of urban recreational walking were favoured and selected for inclusion. Thereafter, where possible, *snowball sampling* (Browne 2005) was also applied. This meant that a number of the original participants became recruiters within subsequent tests. By ensuring that these recruiters were not informed in regard to the variables that were being tested it was possible to preserve the overall credibility of each test.

Alongside the recruitment of participants, focus was directed to the design process and the selection of a 'design paradigm', which might guide the process.

3.3.4 *Grounding the Design Process: Selecting a Design Paradigm*

Kees Dorst (1995) identifies two dominant design 'paradigms'. Taken together, these paradigms can be seen to offer oppositional understandings of the design process. The first, termed the 'rational problem-solving' paradigm, is attributed to Herbert Simon (1996/1969). On Simon's view, the design process is characterised as a 'rational search', aiming at an optimized solution. The second paradigm, 'reflection-in-action', takes its reference from the work of Donald Schön (1983). For Schön, the expert practitioner is seen to reflect on their actions *while* acting and *moves forward* on the *basis* of self-evaluation. In this way, the design process becomes 'a reflective *conversation*' (Dorst 1995:263, italics added), i.e. a process driven by feedback.

In the present enquiry, alignment is made with the latter paradigm, i.e. reflection-in-action. As such, the design process is seen as a *reflective conversation* with, and *within*, the *research* situations. Here, reflection may be said to operate on two levels. Firstly, it occurs in the development of design concepts and artefacts. Here, through the technique of sketching, rapid exploration of possible strategies were pursued (Cross 2007:53). Secondly, within the tests, participants' experience of, and interactions with the designs also led to reflection. This, in turn, was seen to guide the forward iteration of the designs.

Thus, following the above paradigm, in order to launch the design process proper, the researcher began by sketching.

3.3.5 *Preliminary Design Work: Sketching*

Preliminary design work proceeded, exclusively, through the technique of sketching. Throughout this process, Buxton's advice that sketches should be 'intentionally ambiguous' was closely followed. For Buxton, this is necessary as the value of a sketch 'derives from their being able to be interpreted in different ways' (2007:113). Additionally, as Nigel Cross asserts, the technique allows 'half formed ideas to be expressed and to be reflected upon: to be considered, revised, developed, rejected and returned to' (2007:53). Thus, multiple loosely defined drawings were seen to form an extended series of visual responses to the design hypothesis. Eventually, across this body of visual responses, a series of *convergences* were observed in relation to a particular set of interface features. From this observation, in order to continue development, the convergent features were formalised. Formalisation was enabled through an initial set of generative experiments, wherein a series of exploratory designs were produced.

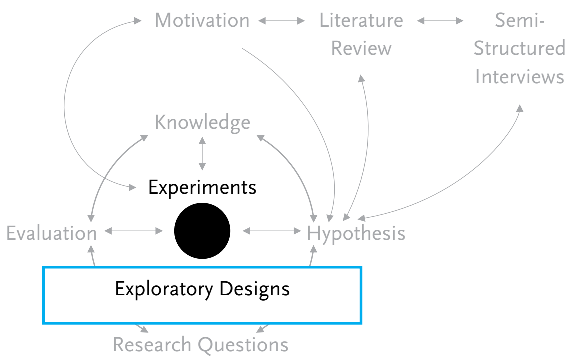


Fig. 3.5 In the exploratory designs a number of alternative designs for particular interface features were explored by the researcher.

3.3.6 The Exploratory Designs

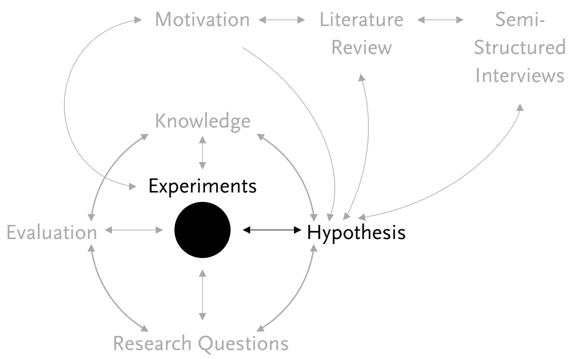


Fig. 3.6 Informed by the literature and interview data, the hypothesis directed practical experiments, with the exploratory designs providing the initial experimental space.

The exploratory design process was inspired by Colin Ware's (2004) concept of a 'testbench application'. Here, Ware recommends that visualisation researchers might develop a 'flexible tool that is capable of producing a range of visual mappings of the data' (p.398). Following this outline, the exploratory design process provided the researcher with a context in which to *explore* variation in relation to specific interface design features. Thus, as experiments, the focus was entirely *heuristic*, i.e. open and generative, rather than deductive.

Within each experiment, abductive reasoning was applied in order to produce an array of *alternative* designs for a specific interface feature.

3.3.6.1 *The Application of Abductive Reasoning within the Exploratory Designs*

As was initially stated in Section 3.1.3 above, abductive reasoning is seen to allow for 'any flight of the imagination provided this imagination ultimately alights upon a possible practical effect' (Peirce 1998/1903:235). It is this form of reasoning that, on the view of Chow and Jonas (2010), underlies a designer's 'generative capacity to conceive and synthesize future systems, situations, and artefacts' (p.9). Thus, in simple terms, imaginative thought has been applied in order to devise possible alternative designs within each array.

3.3.6.2 *Presenting the Exploratory Designs to Participants*

On completion, the arrays of alternative designs were presented to a small group of participants. This was undertaken as an informal means of ensuring that the graphic syntax (Engelhardt 2002) of the designs was *semantically accessible* (i.e. that the arrangement of graphic content in graphic space was *sensible*).

On viewing each design within the array, participants were asked to tell the researcher what was 'around' based on the information presented on screen. In this way, participants were seen to 'beckon' the interface designs 'into being' (Kitchen and Dodge 2008:339). Herein, design-by-design, the researcher sought to pay close attention to the quality of each individual's process of interpretation and identify any potential issues as they arose.

From this, the field simulation test was launched.

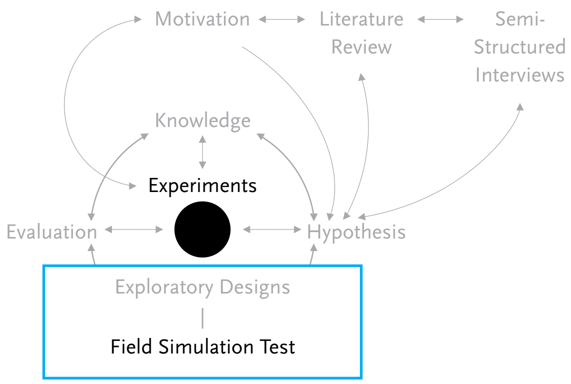


Fig. 3.7 The field simulation test followed on from the exploratory designs. Herein, simulated interface designs were presented to participants in natural settings. Their behaviour was then observed in a brief orientation task. Thereafter they were asked to openly evaluate the interface.

3.3.7 *The Field Simulation Test*

Bryman defines a field simulation as a research technique wherein 'the researcher directly intervenes in and/or manipulates a natural setting in order to observe what happens as a consequence of that intervention' (2008:282). For Endsley and Jones, discussing the design and evaluation of interfaces, 'simulation testing' is seen to provide 'detailed data on performance problems and [the] relative cost and benefits of different design options'. Here, 'design concepts will be refined, discarding troublesome components and improving good components, and reevaluated in an iterative fashion' (2012:54).

Within this enquiry, the field simulation test provided a context in which iterated *simulations* of interface designs could be trialled in 'natural' settings of use. Thus, progress relied on the drawing out of insight in relation to participants' experience of a given interface design in a given environment, as well as to the interface-environment (I-E) interactions exhibited, i.e. to their behaviours in use.

Each test comprised of two sections. Participants were observed using a conventional GPS-enabled WI in one section and a field simulation (FS) design in the other. Both sections were recorded.

> Here, Google Maps was selected as the conventional WI for use in the first section. This selection was made on the basis that, during the course of the research, Google Maps was by far the most popular GPS-enabled WI on the market (Wallop 2011). As such, it was assumed that sampling participants' I-E interactions with Google Maps would provide a reasonable baseline profile against which a comparison could be made with the FS design.

In practical terms, in the first section of the test participants were given a basic orientation task, wherein they were presented with a mobile device displaying the conventional GPS-enabled WI and asked to tell the researcher 'what was around them' based on the information presented on screen. In the second section of the test participants were again presented with a mobile device which this time displayed a FS design and were given the same orientation task. That is, when ready, they were again asked to tell the researcher what was around based on the information that was available to them on screen.

At the end, participants were invited to *openly* evaluate the FS design, noting its positives and negatives. These evaluations guided further iteration of the interface, through the continued application of abductive reasoning.

3.3.7.1 *The Application of Abductive Reasoning within the Field Simulation Test*

In applying abductive reasoning in the field simulation test, the researcher moved from hypothesis, to experiment, to evaluation and back again iteratively. Referring to the below diagrammatic overview of the enquiry, we see these three steps set out in sequence.

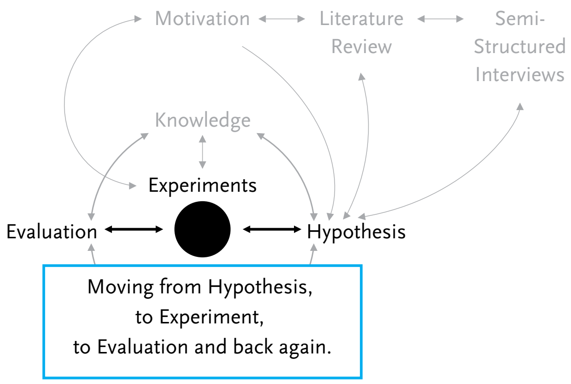


Fig. 3.8 Within each field simulation the researcher trials a design. Thereafter, with the feedback gathered through the participant's open evaluation, the hypothesis is returned to.

In the first step, the interface was *openly* evaluated by participants.

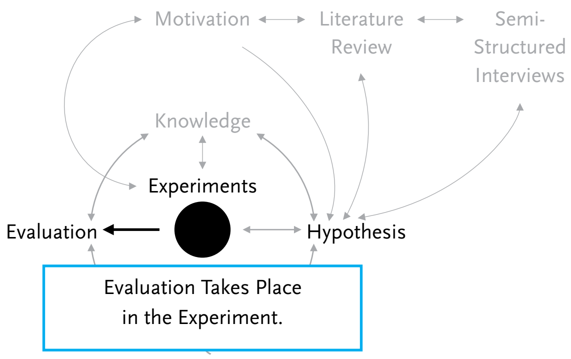


Fig. 3.9 As a first step within the process, participants openly evaluate the design.

This evaluation provided feedback. As a second step, in order to *respond* to this feedback, the researcher returned to the hypothesis.

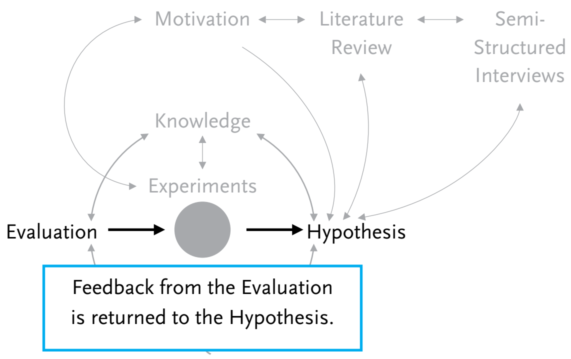


Fig. 3.10 As a second step, with the feedback gathered through evaluation the researcher returns to the design hypothesis.

Having returned to the hypothesis, a third step was taken. Here, through reflection, a judgement was made in relation to whether or not the feedback was relevant. That is, whether or not it aligned with the hypothesis's point of origin: the results of analysis of the interview data. If the feedback was deemed relevant, a response was formulated. Here, abductive reasoning was again applied as a means of incorporating any renewed understandings of the interface design *within* a new, revised design.

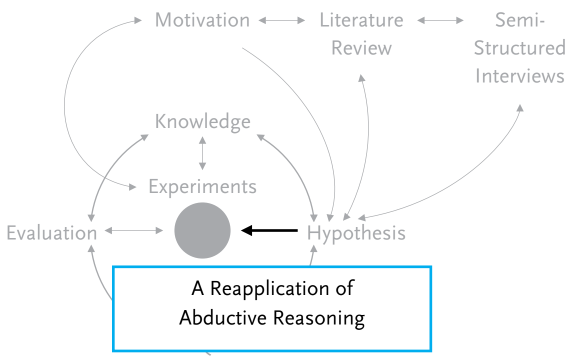


Fig. 3.11 Lastly, as a final step, a considered response is made in relation to the feedback acquired through evaluation. Abductive reasoning is again applied in order to develop a new design.

Alongside this, participants' behaviours were observed as a means of drawing out insight in relation to their I-E interactions.

3.3.7.2 *Developing and Applying an Observation Schedule and Analysing the Results*

In analysing the observation data recorded within the field simulation test, it was first necessary to develop an observation *schedule*, i.e. a formal coding scheme against which participants' behaviours might be observed (Bryman 2008:273). In order to do so the researcher began to tentatively code the behaviours of individual participants within both parts of the test (i.e. in relation to participants' use of the conventional WI and the FS design). This eventually led to the development of a formal schedule, allowing for the consistent collection of observation data.

After collection, each participant's set of results (i.e. their conventional WI and FS design results), were paired to form a *case series* (Farringdon et al. 1996). Thus, working on a case-by-case basis, through a 'simple analysis of variance' (Robson 2011:459), individual differences in behaviours were revealed and a trend was identified across the series.

Once a satisfactory level of refinement had been reached within the FS designs (see Section 5.3.6), focus was directed towards launching a prototype test.

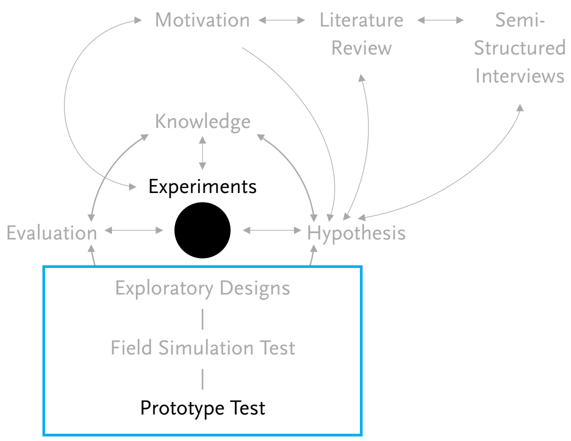


Fig. 3.12 The enquiry's final design experiment, the prototype test, involved the development and trialling of a mix-fidelity prototype.

3.3.8 The Prototype Test

For the prototype test, a mixed-fidelity working prototype (Lim et. al 2008) was developed and trialled. Here, the term 'mixed fidelity' refers to a design which may be seen to demonstrate both *high*-fidelity and *low*-fidelity features simultaneously. Thus, in line with the scope of the test (wherein focus was directed towards the arrangement of graphic content in graphic space), the prototype's *visual* features were rendered in *high*-fidelity, while its dynamic and interactive aspects remained *low*-fidelity. This follows the recommendation of Lim et al. (2008), who argue that a prototype should act as a 'manifestation that, in its simplest form, filters the qualities in which the designers are interested, without distorting the understanding of the whole' (p.1).

As was the case in the field simulation test (see Section 3.3.7), the prototype test was divided into two separate sections.

> In the first section, participants were given a basic Google Maps orientation task. Here, they were asked to tell the researcher what was 'around' them based on the information presented on screen. All participants were videoed during this section, allowing for the collection of quantitative data in relation to their I-E interactions.

Then, in the second section of the test, participants were asked to go for an unaccompanied walk along a one-kilometre route. On the walk, they were instructed to 'use' the prototype at least twice. Use was here presented as a simple matter of pressing a button at the bottom of the screen, which the researcher demonstrated at the start of the walk. It is held that this brief demonstration afforded a reasonable period of time in which the participant might adjust to the interface's initial novelty. In order to record participants during this section of the test it was necessary to ask them to wear a baseball hat fitted with a miniature camera. Again, through observation, this allowed for the collection of quantitative data in relation to their I-E interactions.

After the walk, at the route's end, the researcher met with each participant. At this point a semi-structured interview took place, wherein qualitative data was collected.

3.3.8.1 *The Semi-Structured Interview: Data Collection and Analysis*

Semi-structured interviews were conducted in order to collect data against which the success of the prototype might be assessed. Further, additional data was also collected in order that a contextualised graphic syntax *for* design could later be generated (Engelhardt 2002; Zimmerman et al. 2010). Thus, it was necessary to devise an interview *guide* (Bryman 2008:471), which might *enable* assessment and eventually *allow* for the generation of a contextualised graphic syntax.

In order to enable assessment the researcher asked two questions.

The first related to participants' experiences with the prototype (i.e. what happened in use). The second related to their experience of the prototype and Google Maps (i.e. what was each like to use).

It was intended that data collected in response to the first question, would be assessed for the components of exploratory wayfinding identified in the enquiry's first phase (see Section 4.2.2). Such an assessment would allow the researcher to judge whether or not exploratory wayfinding practices might still be possible in use.

Next, it was intended that data collected in response to the second line of questioning would later be integrated with the quantitative data collected through observation. Such integration would allow for an assessment of whether or not SA-in-use had been supported against the statement set forth in the conceptual framework (see Section 2.4). This, in turn, would make it possible to ascertain whether or not the design hypothesis had been verified.

Beyond the above, in order to facilitate the generation of a contextualised graphic syntax, two further questions were asked. These related to participants' information design experience (i.e. their interpretation of the arrangement of the graphic content in graphic space) and the meaning they ascribed to the interface (i.e. what they thought it was for). (The specific questions asked are presented in Section 5.4.4, along with a detailed outline of the testing process).

As in the analysis of the semi-structured interviews in the enquiry's first phase, IPA (see section 3.2.5) was applied in order to draw out insight in relation to participants' experience of the prototype.

Here, each interview was transcribed and then read through several times. In these readings extensive annotation took place. As before, this annotation gave way to a number of coded categories, which, in turn underwent gradual refinement. At the end of the process, the final codes were converted into defined *themes*. Then, from these, broader organising themes were developed, which allowed for the general grouping of the data.

The above process of *qualitative* data collection and analysis was paralleled by a concurrent process of *quantitative* data collection and analysis through observation of participants' behaviours in the video recordings.

3.3.8.2 *The Observations of Behaviours: Data Collection and Analysis*

In collecting quantitative data through observation of each participant's use of the conventional WI and the prototype, focus was directed towards their I-E interactions in order that any differences in behaviour might be detected. However, as Endsley and Jones warn, due to variable test conditions in field settings it is often difficult to attribute differences in 'performances that occur between different systems design' to the design alone (2012:55). Thus, participants' use of the conventional WI within the orientation task was this time taken as a *contrasting baseline profile* against which their use of the prototype on the walk might be compared. (See Section 5.4.5 for details regarding the eventual parameters applied in the consideration of both sets of behaviours).

As with the analysis of the field simulation test each participant's data was paired and arranged as a case series (Farringdon et al. 1996). A variance analysis was then conducted on a case-by-case basis and, from this, across the aggregate. Thus, it was possible to identify a general trend for the group as a whole.

From the above, it is important to recall that the sampling of participants, was *purposive* and, as such, 'non-random'. Consequently, the test cannot be viewed as a true experiment, but rather must be seen as a 'quasi-experiment' (Robson 2011:109). Thus, no test of statistical significance, i.e. a *t-test* (ibid:450), was performed and the results must be seen as *non-generalisable*. In other words—as is the case with many prototype tests (Goodman et al. 2012:315)—they cannot be assumed to hold across a large population. Rather, the results presented here are offered as a *suggestion* of what *may* be the case. It is hoped that by providing a 'thick' description of the research within this thesis (Geertz 1973), the *transferability* (Lincoln an Guba 1985:316) of this enquiry will be robust enough to enable future research to *trial* its results.

Having collected and analysed both qualitative and quantitative data through the techniques of interview and observation, it was then necessary to seek to intregrate the two sets of results.

> It was intended that integration would allow for an assessment of whether or not SA-in-use had been supported against the statement set out in relation to this in the conceptual framework (see Sections 2.4 and 3.3.1).

3.3.8.3 *Integrating the Qualitative and Quantitative Results and Assessing for Situation Awareness in Use*

Integration of the qualitative and quantitative results was enabled by the conversion of participants' quantified behaviours into *qualitative* descriptions, i.e. narratives (Bazeley 2009:205). In the end, each participant was assigned a single statement, which *qualified* their overall level of I-E interactions. Thus, each could be directly compared, one to the other. Such an approach has been referred to elsewhere as *qualitizing* (Tashakkori and Teddlie 1998). (A full outline of this process, and the various steps involved, may be found in Section 5.4.5.1 and Appendix E).

In order to integrate the results of the final prototype test each participant's *qualitized* behaviours were set beside the themes that had emerged in their account of their *experience of* both interfaces (i.e. the conventional WI and the prototype; see Sections 3.3.8.1). Thus, in this way, participant-by-participant a fully integrated dataset was realised, revealing each individual's pattern of experience and behaviour.

With these patterns available, it was possible for the researcher to assess for the support of SA-in-use. Here, the researcher returned to the statement, set forth in the conceptual framework (see Sections 2.4 and 3.3.1), relating to how one might reasonably assert that SA-in-use had been supported. This statement provided criteria against which each participant's individual pattern could be assessed.

Having conducted this assessment it was possible to ascertain whether or not the design hypothesis had been verified. From this, the prototype's graphic syntax was defined and thereafter contextualised.

3.3.9 *Generating a Contextualised Graphic Syntax*

Engelhardt's graphic syntax theory (2002) was applied as an analytic framework in the definition of the prototype interface's graphic syntax (see Section 2.1.5.4).

Once defined, the interface's graphic syntax was then contextualised through the interweaving of three additional strands relating to: the background of the interview participant (IP) group, providing a who-where-when; participants' information design experience in the prototype test, i.e. their interpretations of the arrangement of graphic content in graphic space (see Section 3.3.8.1 above); and the meanings participants ascribed to the interface, i.e. what they thought it was for (see Section 3.3.8.1 above).

To ensure that threats to the contextualisation's *credibility* (or in conventional terms its *validity*) were avoided, it was necessary to engage in negative case analysis (Lincoln and Guba 1985:309; Robson 2011:157). That is, those cases, which did not 'fit', were probed so that their particularities might enrich the whole (see Section 6.1.2.1). Additionally, as a final step, member checking (Lincoln and Guba 1985:301) was undertaken so that participants were given an opportunity to *react* to an initial contextualised graphic syntax (see Appendix H).

We have thereby outlined this enquiry's methodological stance, as well as detailed its methods. In the following chapter we move on to look at the results of the first phase: the programme of semi-structured interviews with urban recreational walkers/wanderers.

Summary

This chapter has provided an overview of the particular methodological stance that has been developed through the course of the enquiry, as well as detailed its methods. It was made up of three sections.

In first section the particulars of the research strategy were considered, looking both at the approach to practice-based enquiry, as well as the positioning of practice-based contributions to knowledge. Additionally, the enquiry's theoretical perspective—pragmatism—was elaborated upon. This was followed by an overview of the particular evaluation criteria that have been here nominated (i.e. credibility, transferability, dependability and confirmability).

In the second section, the enquiry's first phase—wherein a programme of semi-structured interviews were conducted—was discussed. Here the sampling of participants, the arranging and conducting of interviews, as well as the analysis of data were all considered. Thereafter, the means by which an area for experimentation was framed and, from this, a design hypothesis formulated were also discussed.

In the third section the enquiry's second phase, involving the application of design practice within a series of experiments, was described. Here, an overview of all three experiments was provided, looking at the exploratory designs, the field-simulation test and, lastly, the prototype test. Finally, at the chapter's end the process of defining and contextualising the graphic syntax for design (Engelhardt 2002; Zimmerman et al. 2010) was set out.

Endnotes

1. It must here be noted that Peirce took an active dislike to the pragmatist label as set forth by James in a series of lectures delivered in 1905. Thus, in order to avoid any association between his philosophic project and the latter label, he coined the novel term pragmaticism (Menand 2002:347-351). While this disparity is acknowledged, it is held that in the context of the present enquiry it is more helpful and straightforward to group Peirce, James and Dewey as pragmatists and interweave their complimentary perspectives.
2. Here, the concepts of 'firstness', 'secondness' and 'thirdness' are seen to lead to an understanding of phenomena. Firstness and secondness refer to that which is immediately experienced. Thirdness refers to the final inferential layer of analysis, in which interpretation takes place (Bernstein 2010:131-132).

4.
Interviews with Walkers/ Wanderers

Having set out the enquiry's methodology in the last chapter, we now move on to discuss the results of the first phase of this enquiry. Here, a series of semi-structured interviews with urban recreational walkers/wanderers were conducted with a view to identifying how the activity is approached and practiced, as well as how GPS-enabled wayfinding interfaces (WIS) are used and negatively perceived therein. The chapter is divided into three sections. In the first section, participants' backgrounds will be briefly outlined. This will allow us to gain an overarching perspective on the group. In the second section the results of the analysis will be set out. Here, participants' responses to key questions will be explored through the aid of a series of mappings. Finally, in the third section, against this analysis we move to frame an area for experimentation and, in turn, shall seek to formulate a design hypothesis.

4.1 The Participant Group

As the enquiry followed a dual programme of purposive and snowball sampling (see Section 3.2.1) a varied, yet ultimately connected group of participants were recruited. In order to track the many personal contexts assembled within the group, each interview included a brief conversation, wherein relevant details relating to each interview participant's (IP) individual background were sought. Here, focus was directed towards the participant's age, place of residence, as well as to how frequently they walked in an urban recreational context. By gathering these together, we are able to comment on the 'shape' of the group as a whole.

Before proceeding, however, it should be noted that the interviews of IP#1, IP#22 and IP#30 have been excluded from the following discussion. In the case of IP#1, the recording failed and, as such, no data was collected. Then, in interviewing IP#22 and IP#30, it transpired that neither engaged in urban recreational walking/wandering[1] and, thus, were both found to be unsuitable as participants.

Having made this exclusion, we shall now move to briefly look at the age-profile, places of residence, as well as the levels of frequency claimed by the final group.

We begin with age profile. Here, while a balanced distribution across all age ranges was initially sought, the application of snowballing sampling meant that in some cases it was preferable to accept a participant for inclusion rather than reject them simply on the grounds of age. This resulted in the majority of the group presenting within the 25-34 range. While this reflects the shape of the particular networks that were accessed through sampling, it may also reflect the lower levels of responsibility experienced by those in their late-twenties and early thirties, i.e. that they are 'time-rich'. Significantly, one of the participants in this category had recently become a mother and in her interview spoke of how her walking practice had transformed since the birth of her child. It was no longer a personal, solitary experience but rather had now become 'family time'. Beyond this range, other age groups were represented by roughly comparable numbers of participants (i.e. three or four per group).

In terms of places of residence, participants were almost exclusively recruited from locations in Britain and Ireland. By far the largest portion of the participant group were drawn from the cities of London and Dublin. This was due to the researcher's then-immediate association with both places. Additionally, through internet recruitment and snowball sampling a number of participants were also drawn from the cities of Manchester, Leeds, Inverness and, in one case, Pittsburgh. The latter recruitment resulted from the recommendation of a Dublin-based participant, who felt that her friend would be an excellent candidate for inclusion within the group. This recommendation was accepted on the basis that the individual had spent a number of years living, working and walking in Dublin and, as such, was seen to hold a relevant understanding of the cultural context.

Next, in regard to the levels of frequency claimed by individual participants in relation to their practice of urban recreational walking/wandering, three general levels were seen to emerge: infrequent walkers, medium frequency walkers, and frequent walkers.

Infrequent walkers claimed to walk once monthly or less. Medium frequency walkers claimed to walk several times a month. Finally, frequent walkers claimed to walk once a week or more. The final distribution is set out on the below table, with each participant's practice qualified.

Participants' Levels of Frequency

Levels of Frequency (Claimed in Relation to the Practice of Urban Recreational Walking)	Individual IP (In order of assigned number)
Infrequent	IP#2 (Only walks recreationally as a tourist); IP#3 (Only walks recreationally with friends); IP#4 (Only walks monthly or bi-monthly); IP#6 (Has recently begun urban recreational walking and wants to walk more); IP#8 (Walks recreationally infrequently but takes extended walks when he does so); IP#10 (Has been a regular urban recreationally walker in the past, but is now too 'busy'); IP#28 (Has been a frequent urban recreationally walker in the past, but less so now that he lives outside of Inverness).
Medium Frequency	IP#11 (Walks recreationally as a means of getting 'to know London a bit more'); IP#23 (Walks recreationally twice monthly, but embeds walking into daily life).
Frequent	IP#5 (Walks recreationally weekly); IP#7 (Embeds walking into daily life. 'Often' wanders at opportune times); IP#9 (Walks recreationally daily); IP#12 (Walks recreationally daily); IP#13 (Walks recreationally weekly); IP#14 (Walks recreationally several times a week); IP#15 (Walks recreationally weekly with her family); IP#16 (Walks recreationally several times a week); IP#17 (Embeds walking into daily life); IP#18 (Walks recreationally daily); IP#19 (Walks recreationally daily. Embeds route variation within routine walks); IP#20 (Walks 'all the time'); IP#21 (Walks recreationally daily as an 'escape'); IP#24 (Embeds walking into daily life); IP#26 (Embeds walking into daily life and often walks 'for the hell of it'); IP#25 (Walks recreationally weekly); IP#27 (Embeds walking into daily life); IP#29 (Dérives at least weekly); IP#31 (Embeds walking into daily life).

Table 4.1 Participants' levels of frequency in relation to urban recreational walking. It will be noted that a qualification is provided for each participant, such that a more detailed insight may be gained.

As the distribution across the above table demonstrates, the majority of participants claimed to be frequent walkers. However, close inspection of the data reveals that, within this frequency their practices remain diverse. Here, two broad distinctions can be made. Firstly, many participants claimed to walk recreationally daily or almost daily, and were clear that this was an active choice on their part. Secondly, several participants had embedded walking within their daily life such that it was integrated within their routines.

In doing so they appear to have embedded recreational aspects into what might otherwise be seen as a prosaic experience. For example, IP#24 mentioned how, on his commute, he would often take longer routes simply because these were more 'pleasant'. IP#8 mentioned that he would 'often' take the opportunity to wander if he found himself waiting for a bus or had time to spare in the city.

In addition to this diversity, it is also important to note that while we are here able to gain an insight into the extent to which walking is practiced, these levels of frequency do not represent a participant's 'felt' commitment to the activity. For example, at the time of interview, IP#10 claimed to be an infrequent walker. She stated this was due to her having recently 'been busy', rather than any lack of motivation or interest. Likewise, IP#28 had once been a frequent urban recreational walker/wanderer, but cannot do so now that he lives in a rural location. As such, we cannot assume that a participant's level frequency is representative of the value they place on the activity.

Before moving on, it will be useful to briefly summarise the above. In terms of age, we may say that the majority of our participant group are relatively young, i.e. aged between 25-34. In terms of place of residence, the majority of our group are London-based but, this is diffused by a large number of participants who are Dublin-based, and a smaller number who reside in other British cities. Finally, while the majority of the group claimed to be frequent recreational walkers/wanderers, two distinct forms of practice were identified. Some participants were seen to make a conscious effort to engage in recreational walking/wandering on a daily, or almost daily, basis. Others had embedded recreational walking practices within routine activities (e.g. commuting), thus transforming what might be viewed as a prosaic experience. Finally, beyond this, the level of frequency claimed by individual participants was shown, in some cases, to be unrepresentative of their 'felt' commitment to the practice of urban recreational walking/wandering. Accordingly, this is not taken a register of the value of the activity for a participant.

With the above overview of the group to hand, let us now move on to present the results of analysis of the interview data.

4.2 The Results of Analysis

In analysing the interview data, the researcher applied interpretive phenomenological analysis (IPA) in order to identify how urban recreational walking/wandering is approached and practiced (see Section 3.2.5 for a detailed outline of IPA).

Analysis commenced before the programme of semi-structured interviews was complete. Here, the researcher read through the first set of transcripts and began to annotate them with comments and memos. Thereafter, in common with thematic analysis (Bryman 2008:578), these annotations were transformed into a series of coded categories, which underwent cyclical development until they were finally converted into defined themes. With these basic themes in place, it was then possible to identify broader, organising themes, which allowed for the general grouping of the data.

Throughout the above process, the researcher's attention was directed to those questions which were deemed to be the most relevant to the enquiry's focus, i.e. the design of GPS-enabled WIs for urban recreational walkers/wanderers. These were as follows:

Q.2: What motivates you to walk?

Q.9: If [you have ever walked through a location without a fixed route or plan in mind] can you describe the experience?

Q.10: When you are in an unfamiliar location what resources do you usually draw on in order to find your way as you walk?

Q.11: Thinking specifically of (city) maps, what features do you find most useful as you walk?

Q.15: If [you use mobile maps] can you please describe how you use them?

Q.16: What are the positives and negatives of mobile map use?

In outlining the results, the flow of the following subsections mirrors the sequence of the above listing. Thus, we discuss participants' motivations to walk/wander, their experience of exploratory wayfinding, and their use of wayfinding materials, before proceeding to cover GPS-enabled technology in particular.

Throughout, the broader, organising themes will first be discussed so that a general impression of the data may be obtained. Thereafter, the more frequent basic themes are dealt with. Additionally, for each section, a visual mapping of the data is provided, offering an overview of the complete set of themes as well as the regularity with which they were seen to emerge.

We begin, then, by discussing participants' motivations to walk/wanderer.

4.2.1 *Participants' Motivations*

Most participants were able to list several underpinning motivations in relation to their practice of urban recreational walking/wandering. Herein, two broader organising themes were seen to emerge: *intrinsic* motivations and *extrinsic* motivations. An intrinsic motivation was seen to refer to those forms of experience, which, are *only* available through walking/wandering, i.e. no other activity could satisfactorily replace the walk. Conversely, an extrinsic motivation was seen to refer to a *benefit* that is accrued through the act of walking/wandering but may also be readily available within *other* forms of experience. The full set of basic themes associated with participants' motivations are listed as being either intrinsic or extrinsic on the below table.

The Organising Themes Relating to Participants' Motivations to Walk/Wander

Organising Theme	Definition	Basic Themes
Intrinsic Motivations	A motivation indicating a form of experience, which is only available through walking/wandering, i.e. no other form of experience would satisfactorily replace the walk.	A feeling. Addicted to walking. Chance. Enjoyablity. Exploration. Interest in a place. Investigation. Political critique. Aids thinking. More Authentic and memorable. Place learning. Restlessness. Escape. Seeking inspiration. The feeling afterwards. The immediate experience. To see.
Extrinsic Motivations	A motivation indicating a benefit that is accrued through the act of walking/wandering but may also be available through other forms of experience.	Dog walking. Exercise. Fresh air. No cost. Reliable as a means of transport. Seeking inspiration. Social.

Table 4.2 The basic themes relating to participants' motivations to walk/wander divided into two broader, organising themes: intrinsic and extrinsic motivations.

Across the group, three key basic themes emerge with particular regularity. These are: *exploration*, the desire *to see*, and *exercise*. Beyond these, *the immediate experience* of walking/wandering, its *social* associations and the *enjoyablity* of walking/wandering were also held to be significant. In order to gain a clear understanding of these themes, it will be useful to briefly consider each in detail, beginning with *exploration*.

With the intrinsic theme of *exploration* participants claimed that their walking/wandering was motivated by a desire to engage in actions which suggest an *investigative* attitude. Here, several spoke of how they were motivated to find things. For example, for IP#7 recreational walking/wandering was a means of '...trying to find out something about the way... a city works really, from the ground up...' Some explicitly used the word 'explore'. Others spoke of *discovery*. Further to these, several participants claimed that their walking/wandering was driven by a sense of curiosity, 'nosiness', or interest.

The second most popular theme to emerge within the data was the intrinsic motivation, *to see*. This theme bears close relation to the theme of *exploration*, yet it is held to be distinct on the basis that participants were here keen to emphasise the *visual* aspect of their experience, suggesting a somewhat more passive involvement. Herein, all participants explicitly mention the act of 'seeing'. For most, this was discussed in terms of the whole environment. Here, for example, IP#20 noted how the act of seeing allowed him to be 'part' of urban 'activity'.

> '... the city is full of activity and to be a part of it I at least have to be seeing it.'
> —IP#20

Further to these, IP#9, a design historian, highlighted how she walked/wandered so as she could 'see' unexpected and intriguing forms of lettering on buildings.

With the *extrinsic* theme of *exercise* participants claimed that they were motivated to walk/wander either to get exercise or else to derive specific health benefits. In terms of the latter, IP#27 stated that walking/wandering allowed him to 'keep one's limbs in good order'.

Then with the *extrinsic* theme of walking/wandering as a *social* activity, participants spoke of being motivated to walk/wander on the basis that it allowed them to spend time with others. For some, this meant meeting friends and, in one case, immediate family.

Next, with the *intrinsic* theme of *the immediate experience* participants spoke of being motivated to walk/wander in terms of the affect it induced. For a few participants, this was simply referred to as the 'experience'. Others described how, through walking/wandering, they became involved in a process of *feeling* out a city.

Lastly, with the *intrinsic* theme of *enjoyablity*, participants expressed an appreciation or preference for walking/wandering in and for itself. Some participants simply stated that walking/wandering was something they enjoyed or liked. Others were here keen to draw a contrast to other forms of transportation. IP#24, in particular, stated that:

> 'I— rarely take public transport so it's just part of my day and it's both necessary, you know, I have to commute in a way, but also it's something that I've always enjoyed.'
> —IP#24

Having outlined the significant themes underpinning participants' motivations we will now move on to discuss participants' exploratory wayfinding practices (see Section 2.3.2.1).

4.2.2 *Participants' Components of Exploratory Wayfinding*

When asked whether or not they had ever walked 'without a fixed route or plan in mind' in an urban environment, i.e. engaged in exploratory wayfinding, almost all participants responded positively (only three did not). Some were tentative and, in answering, sought to clarify their own approach to such activity. Here, most claimed that they engaged in exploratory wayfinding but only in particular circumstances, such as when the opportunity presented itself, or when abroad, or within the framework of pyschogeographic practice. Additionally, one claimed to engage in exploratory wayfinding but always with a direction in mind. The remaining participants were indefinite in stating whether or not they engaged in exploratory wayfinding, yet still claimed to do so.

Beyond the above, the majority of the group claimed to engage in exploratory wayfinding either *enthusiastically* or *regularly* and so were able to describe their experience in detail.

The accounts offered varied in structure. Some chose to refer to a single experience while others spoke in more abstract terms. In all cases, it was however possible to identify a number of *components* of exploratory wayfinding practice emerging from within the data. Herein, two broad organising themes were identified: *tactical* components, and *experiential* components. Tactical components were those wherein particular actions or approaches to action were discussed (e.g. *directional movement*). Experiential components, on the other hand, were those wherein particular human-environment transactions were discussed (e.g. *experiencing the unfamiliar*). The full set of basic components are listed as either *tactical* or *experiential* on the below table.

The Organising Themes Relating to Participants' Components of Exploratory Wayfinding

Organising Theme	Definition	Basic Components
Tactical Component	A component referring to a particular action or approach to action in the exploratory wayfinding process.	Aiming. Compelled by the immediate. Directional movement. Extending beyond the familiar. Exploration. Lessening one's familiarity. Linking to the familiar. Loose knowing (of location). Path following. Psychogeographic routing. Purposeful unorthodox routing. Seeking engagement. Situated observation. Taking emergent paths. The influence of emotion.
Experiential Component	A component referring to a particular human-environment transaction which occurs in the exploratory wayfinding process.	A positivity in getting lost. Contemplation. Emergent paths lead to discovery. Emotional engagement. Experiencing the unfamiliar. Experiencing the unusual. Expanded temporality. Intellectual immersion. Knowing in uncertainty. Learning in slowness. Noticing. Sensual immersion. Unconscious experience.

Table 4.3 The basic components of exploratory wayfinding divided into two organising themes: tactical components and experiential components.

The most frequently occurring components are: *exploration; emergent path taking; directional movement; noticing; compelled by the immediate;* and *linking to the familiar.* In the below table each of these components is linked to an example statement and defined.

The Components of Participants' Experience of Exploratory Wayfinding

Organising Theme	Components	IP No. (In order of assigned number)	Example Statement	Definition
Tactical Components	Exploration	IP#5, IP#18, IP#19 IP#20, IP#25, IP#27, IP#28	'Finding little eighteen-century college houses or looking down lanes at what looked like alms house…' —IP#28	The walker/wanderer seeks intriguing, unanticipated environmental features or experiences.
	Taking Emergent Paths	IP#3, IP#10, IP#11, IP#14, IP#18, IP#31	'I just am—, sort-of, you know, went into one street and, or looked at different streets and I thought "Well this looks interesting" or "This is where I want to go". You pick little alleyways…' —IP#11	The walker/wanderer has no fixed path in mind, and allows the immediate affordances of the environment to shape their route.
	Directional Movement	IP#5, IP#7, IP#10, IP#15, IP#19	'I knew where I was at but from there to the beach, you just needed one direction, like south or something and you'll probably reach the beach…' —IP#5	The walker/wanderer knows the general direction in which they are heading, but not the specifics of the route.
	Linking to the Familiar	IP#4, IP#9, IP#12, IP#13	'…if you keep walking eventually you're going to go somewhere that you know.' —IP#9	In their walking, the walker/wanderer links unfamiliar environments to familiar environments.
	Compelled by the Immediate	IP#25, IP#27, IP#29, IP#31	'…but normally if I'm on my own or I'm somewhere new it would just be what looks interesting. I do have fondness for alleyways generally and bits…' —IP#29	The walker/wanderer makes routing decisions based on encountering particular environmental features or qualities.
Experitential Components	Noticing	IP#6, IP#7, IP#10, IP#21, IP#28	'I noticed things… And a, I remember seeing things like just a dog resting on the pavement, street art, seeing what windows where people had put flowers out the windows and where not.' —IP#10	The walker/wanderer becomes mindful of features within the immediate environment.

Table 4.4 The components of participants' experience of exploratory wayfinding. Here, from left to right, we see: the organising theme; the particular component, the number of the participants grouped within; an example statement associated with each; and the definition applied by the researcher to the component.

Examining the above, a number of comments can be made in relation to each component. With the tactical component of *exploration*, participants were seen to provide examples, which align with the motivational theme of exploration (see Section 4.2.1 above). Emphasis was placed on how, in wandering, intriguing, unanticipated environmental features were sought. Some spoke of exploration or discovery. Others mentioned finding features through walking. IP#20 was more reflective, noting how through the use of guidebooks and apps he has 'realised it's also just about serendipity.' Further to these, IP#25 described tracing the course of an underground river and how, in certain circumstances, he experienced 'surprise' at where he found himself.

Next, with the tactical component of *emergent path taking*, participants spoke of how, when wandering, they have no fixed path in mind, and would allow the immediate affordances of the environment to shape their route. In many cases, participants stated that they made decisions on a street-by-street basis. In addition to these, IP#18 spoke of happily losing her bearings by 'going into the city' along 'a lot of small routes'. Here, it was suggested that her choices were emergent and not pre-planned. Similarly, IP#3 noted how a canal, i.e. a 'path' (Lynch 1960:46; see Section 2.3.2), was followed up until a point at which a viable exit point presented itself. Lastly, IP#14 described a walk in which destinations were *spontaneously* suggested and thereafter visited.

Diverging somewhat from the above, with the tactical component of *directional movement*, participants were seen to outline a subtly different approach. Herein, they spoke of being aware of the general direction in which they were heading, while not necessarily attending to the specifics of the route.

From this, with the *experiential* component of *noticing*, participants spoke of how they could become mindful of the features in the immediate environment as they walked/wandered. Some explicitly mentioned 'noticing' and named several examples of what was *noticed*. Similarly, EP#28 spoke of *seeing* particular things as he walked. Connecting to these, for EP#7 it was a matter of 'taking in as much as possible'. Beyond the above, but related, IP#6 was seen to discuss how, within her practice, she's become increasingly 'aware' of how the 'journey itself' can be interesting.

Next, with the tactical component of *compelled by the immediate* participants claimed to have made routing decisions based on encountering particular environmental features or qualities. IP#29 and IP#31 spoke of finding something 'interesting' and moving toward it. For IP#27, ‘things’ simply attract his attention. Speaking in similar terms, IP#25 offered specific examples of environmental features, which may lead him to take a particular direction. Here, it was not simply a ‘place’ which interested him, but rather momentary qualities arrising in place.

Lastly, the tactical component of *linking to the familiar* emerged out of instances where participants spoke of connecting to familiar places via unfamiliar routes. Some couched this in terms of probability. IP#9, for example, noted how: ‘if you keep walking eventually you’re going to go somewhere that you know...’ IP#4 was more active in her approach. She spoke of *feeling* her way back to ‘what I’m familiar with’. Then, IP#13 spoke of planning routes which allow him to ‘end up falling back’ on those routes with which he is most familiar.

Having explored the above components, we will now turn to look at participants’ use of wayfinding resources and map features.

4.2.3 *Participants’ Use of Wayfinding Resources*

With regard to participants’ use of wayfinding resources in urban recreational walking/wandering, a diverse array of practices were seen to emerge. Some were highly idiosyncratic. For example, IP#9 spoke of how she would read bus stop signage in order gain a sense of direction. IP#10 mentioned using shop names as marker points. While IP#12 claimed to reference the positions of billboards as she moved through cities.

Reviewing the full set of basic themes, four broader organising themes were identified. These were: *environmental resources*, *artefactual resources*, *social resources* and *embodied resources*. Environmental resources grouped fixed objects found in the environment, whether manmade or natural. Artefactual resources grouped manmade mobile information sources, whether analogue or digital. Social resources were those which were seen to arise out of interpersonal exchange. Lastly, embodied resources were those which were seen to refer to personal skills or abilities claimed by participants.

The full set of basic themes are listed on the below table as either environmental, artefactual, social or embodied. We see that most themes are defined as environmental.

The Themes Relating to Participants' Use of Wayfinding Resources

Organising Theme	Definition	Basic Themes Associated with the Organising Theme
Environmental Resources	Wayfinding proceeds based on a fixed object found in the environment, either manmade or natural.	Billboards. Landmarks. Main streets. Public transportation points (e.g. Tube stops). Shop names. Street signage. The look of a place. The sun. You are here maps.
Artefactual Resources	Wayfinding proceeds based on information accrued through a mobile, manmade object, either analogue or digital.	Mobile maps. Paper maps and guides.
Social Resources	Wayfinding proceeds based on an interpersonal exchange.	Other people (i.e. asking).
Embodied Resources	Wayfinding proceeds based on a personal ability or skill.	Intuition. Pyschogeographic technique.

Table 4.5 The basic themes relating to participants' use of wayfinding resources divided between four organising themes: environmental resources, artefactual resources, social resources, and embodied resources.

The most frequently occurring themes were:

Mobile maps;

Other people;

Paper maps and guides;

Landmarks;

Intuition.

Of the above, the *artefactual* theme of *mobile maps* and the *social* theme of *other people* emerged most frequently. With *mobile maps*, participants spoke of using mobile telephones or mobile maps in their wayfinding. With, *other people*, participants spoke of accessing others' knowledge in order to find their way. For some, this was a matter of *asking* for directions. IP#4, however, spoke of drawing on a companion's knowledge: 'Someone else who had been there before'.

Thereafter, with the *environmental* theme of *landmarks*, participants spoke of seeking out highly visible or sizable features in the environment. Here, some were seen to speak in general terms, i.e. they mentioned 'landmarks' or 'buildings' without qualification. Most, however, *did* qualify the *types* of landmarks being drawn upon. IP#5 spoke of seeking out 'super-noticeable' structures. IP#12 mentioned the 'facades' of buildings. For IP#15 'big buildings' were key. IP#27 claimed that he was constantly aware of 'certain linear features'[2]. IP#29 mentioned mountains. Lastly, IP#31 spoke of water features, e.g. rivers and lakes.

With the next *embodied* theme, *intuition*, participants claimed to possess an innate ability to find their way through an environment. Only IP#10 mentioned the word 'intuition' directly. Beyond this, some spoke of having an 'innate sense of direction'. Similarly IP#14 claimed to have an 'inner map', and IP#25 an 'internal compass'. IP#13 stated that he 'generally' followed his 'nose'. Lastly, IP#2 imitated that she would decode general directions in-situ: 'I need to be north so let's figure out where that is.'

4.2.3.1 *Participants' Preferred Map Features*

In discussing which map 'feature' they found most useful, many participants named several. As with their use of wayfinding resources, a number of highly idiosyncratic preferences were identified. For example, IP#4 mentioned cafes and IP#26 mentioned alleyways.

The following themes emerged most frequently:

Cultural landmarks (i.e. buildings);

Parks/open-spaces;

You are here representation.

With the theme of *cultural landmarks* participants spoke of finding the inclusion of significant public buildings or historical features in maps useful. Most explicitly mentioned 'landmarks'. In similar terms, IP#11 spoke of seeking out 'prominent buildings' and IP#27 offered a list of specific features like 'museums, or a historic attraction' which he found useful. In common with the latter case, IP#13 stated that 'anything which brings out the historical context of where you are has an immense amount of value'.

With the theme of *parks/open spaces* participants spoke of how the inclusion of green areas on maps was useful. Many mentioned such features directly. Beyond these, both IP#10 and IP#19 spoke in more detail of how parks were often easily identifiable environmental features and, as such, helpful in orientation when using a map.

Lastly, with the theme of the *you are here representation*, participants spoke of how the representation of their position in maps was useful. The majority spoke in general terms, while some made explicit mention of the inclusion of the representation of their position.

We have thereby discussed participants' use of wayfinding resources and their preferences in relation particular map features. We shall now move on to consider our focus within this enquiry, participants' use of GPS-enabled WIS.

4.2.4 *Participants' Use of GPS-enabled Wayfinding Interfaces*

In questioning participants regarding their use of GPS-enabled WIS (i.e. mobile maps), a majority claimed to use such interfaces while walking/wandering. Many, however, stated that they did not. A number of reasons were given as to why this was the case.

Some participants simply did not own a smartphone, and so had no access to the technology. Others, however, held particular reservations regarding the use of GPS-enabled WIS. Most felt that their experience of walking/wandering would be undermined if they were to intregrate such interfaces within their practice. IP#5 simply stated that she found WIS 'distracting and quite stressful'; they were something to 'get away from' in recreational walking/wandering. For IP#8, the use of such technology seemed 'lazy' and 'aloof'. For IP#13, it was a matter of preserving his spatial knowledge:

> 'You kind of rely on it. And am— that's where it becomes dangerous because am— I walk, I might just get out my phone and start relying on it as a thing that, as the main map that would help me get home or wherever I need to be...'
>
> —IP#13

Lastly, IP#20 felt that the city itself 'was enough to go on'.

These perspectives, in particular those wherein concerns are raised, all relate to issues identified by participants when they were asked to discuss the positives and deficits of GPS-enabled WIS. As such, they will hold our focus in Section 4.2.6.

For now, we will turn to the patterns that were seen to emerge within the accounts of those who *do* use GPS-enabled WIS while walking/wandering. Here, in analysing the data, it was possible to identify 'priority' uses based on how participants initially qualified their accounts of use. Qualification was made through words such as 'probably', 'typically' or 'usually'. By coding participants' descriptions four themed 'priority-uses' were derived. These are set out and defined below on table 4.6.

The Themes Relating to Participants' 'Priority-uses' of Wayfinding Interfaces

Themes	Definition
Orientation	The participant uses the interface en-route to gain a general sense of 'where' they are.
Navigation	The participant uses the interface en-route to gain specific destination-based routing information.
Planning	The participant uses the interface in remote situations to plan specific routes.
Checking	The participant uses the interface en-route to test the viability of particular routing choices.

Table 4.6 The themes relating to participants' main uses of GPS-enabled wayfinding interfaces as they walk/wander in the use-context of urban recreational walking/wandering.

Orientation was the most prominent theme that was seen to emerge. Here, participants claimed that in using GPS-enabled WIs they sought to gain an understanding of 'where' they were. For most, 'where' was associated with broad *generality* as opposed to an exacting *specificity*. As IP#25 put it: 'that's really all I would use it for just, just [to] give [me] a general sense of where I would be going through or near'. IP#15 spoke of finding out 'where I was in relation to where I am'. For IP#17, it was a matter of 'figuring out' where she was. Lastly, IP#21 used GPS-enabled WIs to find out 'where you're in'.

With *navigation*, participants spoke of using GPS-enabled WIs in order to gain specific, *destination-based* routing information as they walked. For IP#2, it was a matter of looking at 'where I need to go to'. IP#23 used them for 'everything', mentioning A-to-B navigation in particular. Then, IP#31 claimed to draw on such interfaces in order to 'work out that last bit of the journey'.

Then, with *checking*, participants spoke of wayfinding in *immediate* terms. Here, IP#24 outlined how he would 'look' at his phone periodically and 'memorise the next few hundred metres', repeating this action in cycle. Less intensively, IP#28 outlined how, in use, he wanted to know: 'if I go down that place there is that going to take me somewhere that I can get out the other end or am I going to get stuck in a dead-end'.

Finally, in regard to *planning*, IP#27 stated that he would use GPS-enabled WIs for 'public transport journeys'.

Reflecting on the above, we may draw a clear distinction between those accounts relating to the theme of *orientation* and those relating to the themes of *navigation*, *planning*, and *checking*. It would appear that those relating to the theme of orientation are seeking *general* information regarding 'where' they are, while those in the latter categories prefer highly *specific*, *detailed* information in order that they may confidently make decisions in regard to their route choices.

Having provided an overview of participants' accounts of their use of GPS-enabled WIS, we will now move on to consider what they perceived to be the positives and deficits of this technology, beginning with the positives.

4.2.5 *The Perceived Positives of GPS-enabled Wayfinding Interfaces in an Urban Recreational Walking/Wandering Context*

In identifying the positive attributes of GPS-enabled WIS, participants referred not only to their role within the experience of walking/wandering, but also to a range of technical and interactive aspects. The full set of basic themes are listed on the below table as either *experiential*, *technical* or *interactive* positives.

The Basic Themes Relating to the Perceived Positives of GPS-enabled WI Use

Organising Theme	Definition	Basic Themes Associated with the Organising Theme
Experiential Positives	Positives relating to the affect of the interface in immediate, felt terms within the context of urban recreational walking/wandering.	A sense of security. Allows for post-walk analysis. Convenient. Compass orientation. Easy portability. Egocentric mapping. Flexibility. Footpaths displayed. Good general content level. Helpful aboard. Immediate availability. Limitless scope. No getting lost. Opens up possibilities. Revealing unknowns. Visual accessibility.
Interactive Positives	Positives relating to the two-way flow of information between the user and the system.	Easy to use. Location-based services. Navigation. Updatable.
Technical Positives	Positives relating to the hardware or the operation of the digital functions.	Locates the user. Reliable.

Table 4.7 The basic themes relating to the perceived positives of GPS-enabled WI use, divided between: experiential positives, interactive positives and technical positives.

From the above, the two prominent themes were:

Sense of security;

Not getting lost.

With the *experiential* theme of *a sense of security*, participants spoke of how the possession of the technology gave them peace of mind. Herein, such interfaces were said to provide 'security', 'safety' and 'reassurance'. For IP#5, it was something, which could be accessed in 'unexpected emergencies'. Connecting with these, IP#14 noted how in unfamiliar, foreign locations wayfinding could be difficult and stressful. As such, in these situations, GPS-enabled WIs could be immensely useful.

Then, with the *experiential* theme of *not getting lost*, participants spoke of how it was no longer possible to lose one's bearings. However, it is worth noting that, in doing so, IP#12 suggested that the removal of the possibility of getting lost should be cast as both a positive *and* a negative attribute. Additionally, IP#25 felt that he himself did not benefit from this because, in his words, he possessed 'an internal compass'.

From these positives we now turn to look at the deficits which were associated with the technology.

4.2.6 The Perceived Deficits of GPS-enabled Wayfinding Interfaces in an Urban Recreational Walking/Wandering Context

When considering the deficits of GPS-enabled WIs, participants, again, made reference to the role of such interfaces within experience, as well as to a range of technical and interactive aspects. The full set of basic themes are listed on the below table as either *experiential*, *technical* or *interactive* deficits.

The Basic Themes Relating to the Perceived Deficits of GPS-enabled WI Use

Organising Theme	Definition	Basic Themes Associated with the Organising Theme
Experiential Deficits	Deficits relating to the affect of the interface in immediate, felt terms within the context of urban recreational walking/wandering.	Destination being prioritised. Lack of detailed terrain. Lack of tangibility. Makes you vulnerable. Maps are distorted. Negation of exploratory wayfinding. No wider context. Overly compelling. Undermines situation awareness. Walking becomes formal. Walk becomes more planned. You don't get a sense of place.
Technical Deficits	Deficits relating to the hardware or the operation of the digital functions.	Battery life. Battery dependent. Inaccurate. Loading times. Unreliability. Screen size.
Interactive Deficits	Deficits relating to the two-way flow of information between the user and the system.	Lack of interactivity with route layout. Fiddly.

Table 4.8 The basic themes relating to the perceived deficits of GPS-enabled WIs divided into three organising themes: experiential deficits, technical deficits and interactive deficits.

From the above, the following themes were seen to emerge with particular regularity in the data:

Undermines situation awareness;
Unreliability;
Negation of exploratory wayfinding.

As we are concerned *explicitly* with how the *design* of GPS-enabled WIS may shape an experience (i.e. urban recreational walking/wandering) it is deemed appropriate to focus only on the *experiential* themes, i.e. those which relate specifically to the design's role within the experience. Thus, in excluding *technical* deficits, our list of significant issues is reduced to the following:

Undermines situation awareness;
Negation of exploratory wayfinding.

The below table provides example statements and definitions for both of these themes.

Participants' Most Frequent Experiential Deficits

Experiential Deficit	IP No. (In order of assigned number)	Example Statements	Definition
Undermining of Situation Awareness	IP#2, IP#7, IP#16, IP#20, IP#21, IP#25, IP#29	'[...] place and landscape, you have a— there is a question of— the kind-of— you know, the non-place of an airport or a motorway, this idea that it doesn't have any relationship to anywhere else, am— with, something like a sort-of a mobile phone or GPS unit, is your relationship with the outside world or is it with this phone or this screen?' —IP#7 'Am— the negative is I think, when you're looking at a map on your phone, you're not paying attention to the environment and the kind-of visual clues and the ambient clues around.' —IP#29	Participants are concerned with how the use of GPS-enabled WIS affects the distribution of attention and focus in urban recreational walking/wandering.
Negation of Exploratory Wayfinding	IP#7, IP#9, IP#10, IP#12, IP#20, IP#28	'The bad things are for these kind of walks for leisure and then walking around, a tourist, it spoils the fun of being lost if you like that.' —IP#9 'Maybe it does take some of the adventure off it because it does mean that you can check for those things that take any of the risk out of it.' —IP#28	Participants are concerned with how GPS-enabled WIS are seen to eliminate the exploratory aspects of urban recreational walking/wandering.

Table 4.9 Participants' two main experiential deficits with example statements and a definition. Here, from left to right we find: the theme; the participants associated with this theme; example statements; and a definition for both.

With the *undermining of situation awareness* theme, in all cases, participants were concerned with how the use of GPS-enabled WIS was seen to affect the *distribution of attention* and *focus*. For some, looking down at the interface is seen to disrupt the flow of direct experience. As IP#2 put it: 'if you're looking down at your phone [...] you're going to miss things'. Others allude to an undesirable reframing of their relationship with the environment. For IP#7, it was a question of primacy: 'is your relationship with the outside world or is it with this phone or this screen?'. Then, IP#25 feels that the 'enjoyment of interacting with the actual route' is affected.

With the *negation of exploratory wayfinding* theme, GPS-enabled WIS are seen to eliminate the exploratory aspects of urban recreational walking/wandering. Here, possibilities are closed, fun is spoiled and adventure is taken. Additionally, IP#12 regrets that with GPS-enabled interfaces you are never lost. Lastly, IP#10 worries whether such technology might lessen one's innate curiosity, such that no effort would be made to 'get somewhere'.

We have thereby reported the entirety of the results derived from analysis of the interview data. In the next section, against this analysis we will move to frame an area for experimentation and, accordingly, shall seek to formulate a design hypothesis in response.

4.3 Framing an Area for Experimentation Against the Results of Analysis and Formulating a Design Hypothesis

In working to *frame an area for experimentation* from the above results, focus was directed towards the interplay between participants' motivations, their priority-uses, and their perceived *experiential* deficits (i.e. those deficits which relate to the *design* rather than to the technology). Thus, *why* a participant walks/wanders, *if/how* they use a GPS-enabled WI and *what* they perceive to be its *experiential* deficits were all linked. Further to this, the researcher chose to draw a contrast between *intrinsic* motivations and *extrinsic* motivations (see Section 4.2.1), as both present alternative perspectives on the activity of urban recreational walking/wandering (i.e. *why* one might walk/wander). The view is here taken that the former group (i.e. those with intrinsic motivations) find value in walking/wandering in and for itself. As such, it is this group to which we will seek to attend to as we constrast both perspectives.

In order to reveal the above linkages and perspectives, two separate mappings were produced. The first, shown in figure 4.1, groups participants' *intrinsic* motivations and, in turn, links these to their priority-uses or type of non-use, as well as to the particular *experiential* deficits identified. The second mapping, shown in figure 4.2, makes the same links but in relation to *extrinsic* rather than *intrinsic* motivations. With these two mappings to hand, it was possible to assess how/if these two perspectives on the activity affect any differences in use or perceived *experiential* deficits; and, if so, how the particular perspective of those who are intrinsically motivated to walk/wander might suggest/indicate an appropriate area for experimentation.

Let us begin by studying the first mapping (figure 4.1)—that of *intrinsic* motivations set next to priority-uses and experiential deficits. Surveying the middle row we find that, in this grouping, most use such interfaces for *orientation*. There are also quite a few who choose *not* to use such interfaces on the basis of conviction. Thereafter some participants don't own mobile telephones, while others use WIs for *navigation*, *planning* and *checking*.

Along the bottom, we will notice that the most frequent experiential deficits remain: *undermines situation awareness*; and the *negation of exploratory wayfinding* (as was identified across the group in Section 4.2.6 above).

Figure 4.1 Participants with Intrinsic Motivatations: Their Use of GPS-enabled Wayfinding Interfaces and Perceived Deficits

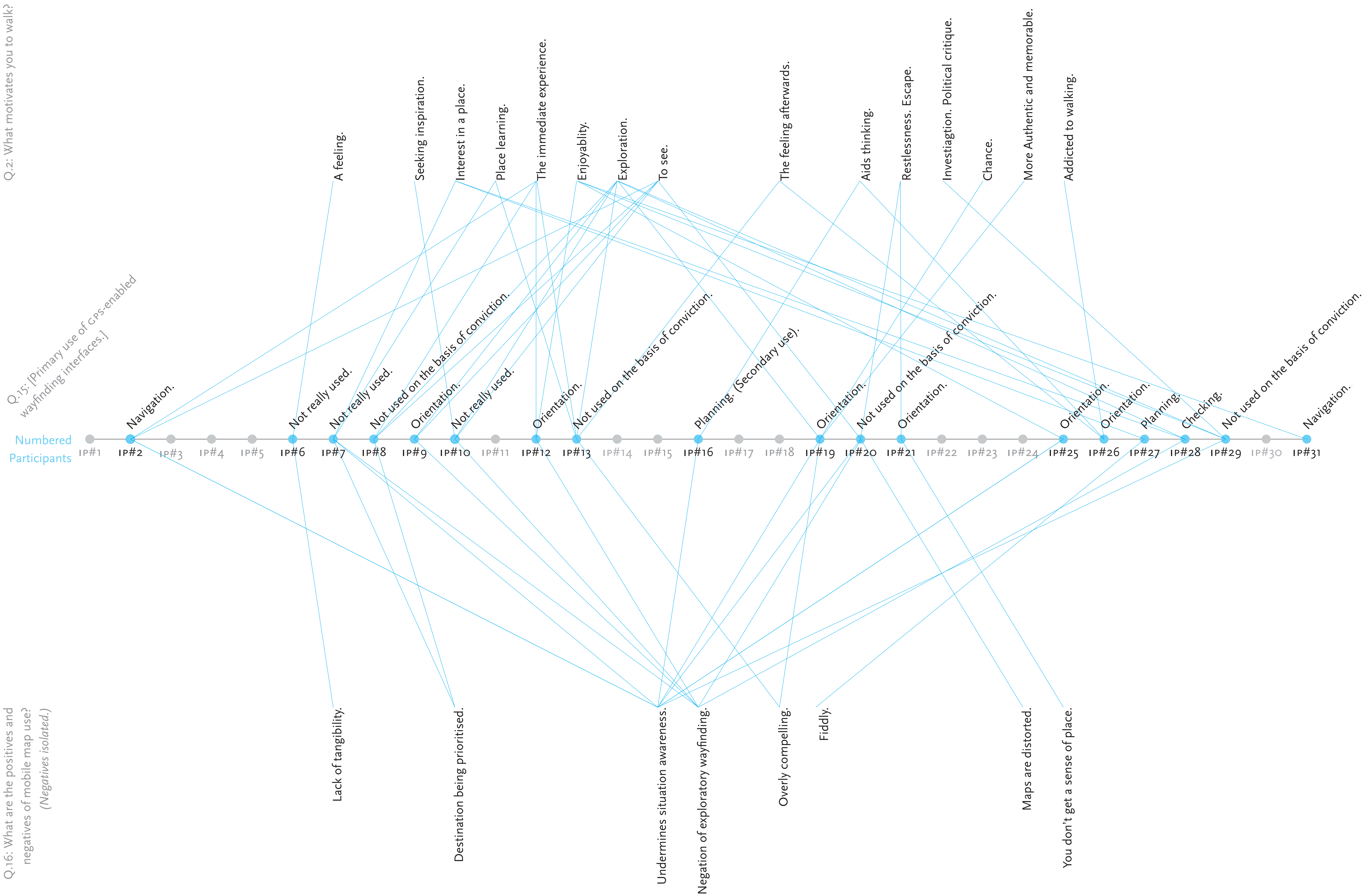
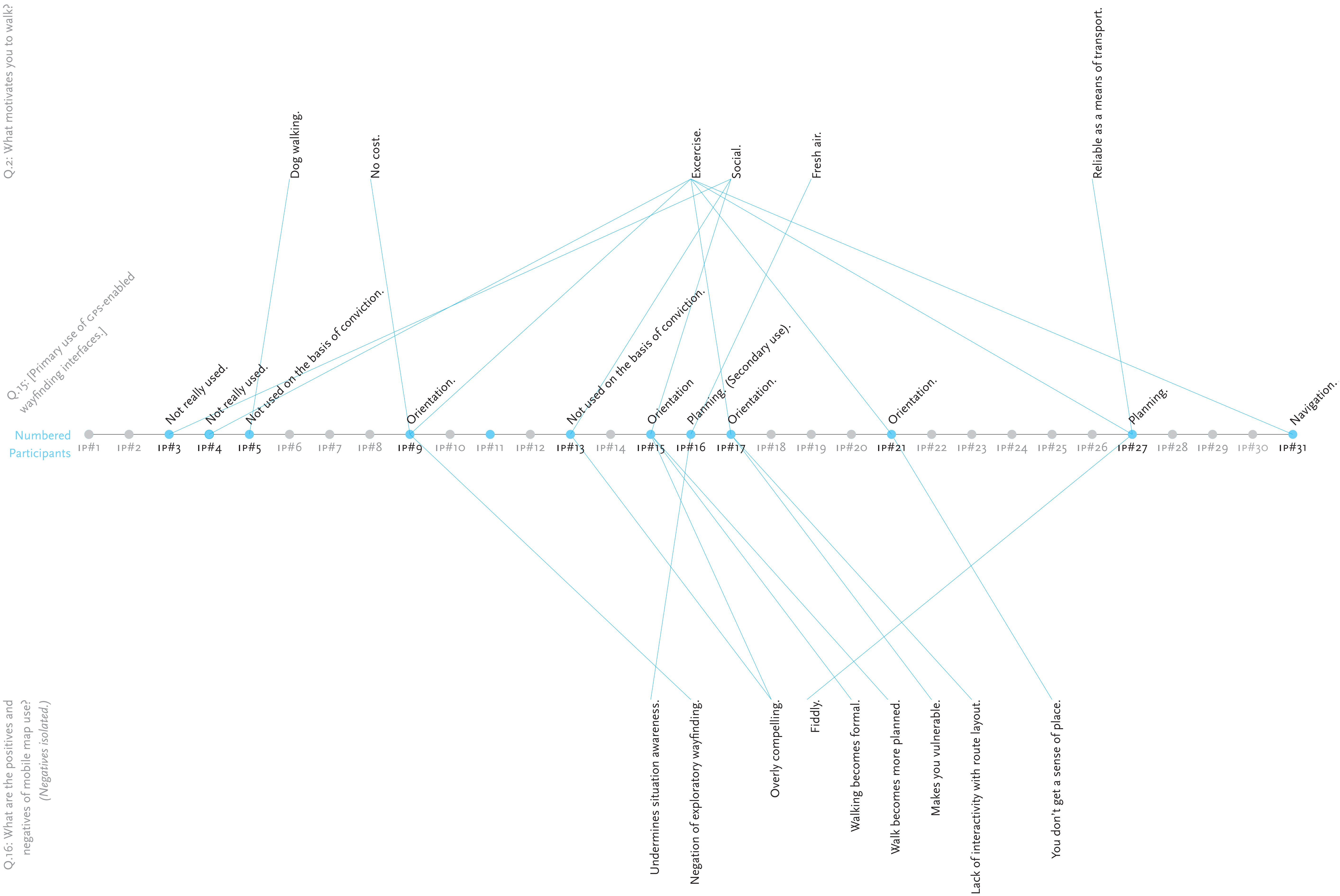


Figure 4.2 Participants with Extrinsic Motivatations: Their Use of GPS-enabled Wayfinding Interfaces and Perceived Deficits



From this, we now turn to the second mapping (figure 4.2)—that of *extrinsic* motivations next to priority-uses and experiential deficits.

Looking to priority-uses along the middle row, we see that, as above, *orientation* emerges as the main priority-use theme. Thereafter, two participants choose *not* to use GPS-enabled WIS on the basis of conviction. Others use them for *navigation* and *planning*. Lastly, one participant, IP#3, has no mobile telephone.

Then, looking to participants' perceived experiential deficits along the bottom, we see that *undermines situation awareness* endures as an issue, but only for a single participant. Equally, the *negation of exploratory wayfinding* also endures but, again, only for a single participant.

Comparing both mappings, we will observe a much larger concentration of those with *intrinsic* motivations do *not* use GPS-enabled WIS on the basis of conviction. Moreover, IP#13 appears on both mappings and, so, IP#5's position (in the *extrinsic* mapping) appears to be somewhat of an anomaly.

In addition to the above, we may also see that a much larger concentration of those who are *intrinsically* motivated cite *undermines situation awareness* and the *negation of exploratory wayfinding* as deficits. Further, it is worth noting again that IP#13 and IP#16, who identify these as deficits on the extrinsic mapping, also hold *intrinsic* motivations (i.e. they appear on both mappings).

From these observations, it would seem that there is a correlation between being *intrinsically* motivated to walk/wander and *not* using GPS-enabled WIS on the basis of a conviction. Equally, it would seem that there is also a correlation between being *intrinsically* motivated to walk/wander and identifying *undermines situation awareness* and the *negation of exploratory wayfinding* as deficits.

With regard to those who do *not* use GPS-enabled WIS on the basis of conviction, in some cases there would appear to be a relationship between *not* using the technology and the above deficits. IP#20 and IP#29 both identify *situation awareness* as a deficit. Further, IP#20 also cites the *negation of exploratory wayfinding*.

Of the two, IP#29 was explicit in stating that the *undermining of situation awareness* prevented her from using the technology. For her, the activity of urban recreational walking/wandering was a matter of enabling 'a personal relationship with space'. Using GPS-enabled WIS meant that 'you're not paying attention to the environment and

[the] kind-of visual clues and the ambient clues around'; and it was these visual and ambient clues, which most held her interest. IP#20 was initially more abstract. In stating that he did not use GPS-enabled WIS while walking/wandering he claimed that 'the city itself is enough to go on'. However, contextualising this, he went on to identify points in time when he *might* use such interfaces. Here, he mentioned certain navigational purposes, such as searching for a cafe. He also spoke of using such interfaces when he found himself 'somewhere boring' and wanted to 'get somewhere that's interesting again'. Thus, it would seem that the technology does play some role in his walking.

This filtered into his discussion of deficits. Here, reflecting on the notion that such interfaces eliminated serendipity (connecting to the *negation of exploratory wayfinding* theme), he went on to clarify:

> 'I think it's more like what they do is help people find their way more effectively and so— they don't get lost accidentally and find delightful things as much unintentionally. And so the serendipitous thing has to be more of an active choice.'
>
> —IP#20

As such, for IP#20, it would appear that the embedding of serendipitous experience within his walking/wandering has become an active choice. This, in turn, has led him to avoid using GPS-enabled WIS, despite his admittance that such interfaces do play role in his walking/wandering.

Reflecting on these two cases, it would seem that *situation awareness* (for IP#29) and the *negation of exploratory wayfinding* (for IP#20) may be contextualised as barriers to use.

IP#8 and IP#13 do not use GPS-enabled WIS either. However, for these two participants, the relationship between non-use and deficits is not so straightforward; neither are seen to identify *situation awareness* or the *negation of exploratory wayfinding* as deficits. Instead, IP#8 felt that use of the interface resulted in the prioritisation of the destination, while IP#13 was concerned that such interfaces were *overly compelling*.

In making explicit reference to his non-use, IP#8 stated that he could 'see points in time when a mobile phone or a GPS would be really useful'. Yet, he continued by adding:

> ‘I just don’t like the *idea* of *surrendering to*. I don’t like the idea of recognising or acknowledging that in that situation cause… and yeah maybe if I had one that was really efficient and really useful then I’d use it… turn into a lazy… bastard.’
>
> —IP#8

With the above reference to laziness we may speculate that IP#8 would rather maintain an active role in the wayfinding process, i.e. he would rather retain control of the ‘shape’ of his experience as opposed to letting it be shaped *by* a *prescriptive* interface. Such a position is seen to align with those taking the view that the use of GPS-enabled WIs results in the *negation of exploratory wayfinding*.

Similarly, in making reference to his non-use, IP#13 was concerned that his level of personal spatial knowledge might be comprised through the use of GPS-enabled WIs. However, like IP#8 above, he also openly recognised that ‘this technology [has] incredible possibility as well’. Such thinking led him to reflect on the researcher’s focus of developing a novel WI for urban recreational walkers/wanderers:

> ‘I would say that what you made would have to be quite simple. Am— in the sense that it shouldn’t really engage the mind too much. So that it shouldn’t be, it shouldn’t have to be sort-of a lot of mind work that goes into it. It should just be a kind-of am— guide…’
>
> —IP#13

From the above, it appears that in order to preserve one’s level of spatial knowledge the participant is suggesting that a *minimal* level of content be provided, such that the interface doesn’t ‘really engage the mind too much.’ Here, it would seem that the participant is implying that, in their current form, GPS-enabled WIs *do engage* the mind too much, i.e. they negatively affect the user’s *distribution of attention* and *focus*. Such a position would align with those taking the view that the use of GPS-enabled WIs results in the *undermining of situation awareness*.

Reflecting on these two cases, it would seem that, again, *situation awareness* (for IP#13) and the *negation of exploratory wayfinding* (for IP#8) may be contextualised as *barriers to use*.

Thus, having revealed linkages across the results, compared the two motivational perspectives, and considered some cases more closely we are now in a position to *frame an area for experimentation.*

To begin, we will summarise the above. It has been identified that, for the group as a whole, *orientation* emerges as *the* priority-use of GPS-enabled WIS. However, a large of portion of those who are *intrinsically* motivated to walk/wander do *not* use GPS-enabled WIS on the basis of conviction. Further, for those who were *intrinsically* motivated to walk/wander, *situation awareness* and the *negation of exploratory wayfinding* emerge as *significant issues* in relation to the use of GPS-enabled WIS. In some cases, these issues may be contextualised as *barriers-to-use*.

Thus, from an information design perspective, we may frame an area for experimentation as follows:

> *We are seeking to identify how the arrangement of graphic content in graphic space on a GPS-enabled wayfinding interface can be designed to support an intrinsically motivated urban recreational walker's/wanderer's situation awareness in use, while also ensuring that exploratory wayfinding practices are still possible.*

Having thereby framed an area for experimentation, we will now move to formulate a design hypothesis in response.

In order to do so, a number of, what will be here termed, 'design propositions' shall be set forth.

Firstly, as the majority of participants claimed orientation as their priority-use, the view is taken that the interface should aim to support such use, i.e. allow the user to derive a general sense of what is 'around' from the interface.

Secondly, in seeking to address the issue of *situation awareness*, it is deemed essential that the interface should aim to rebalance the user's distribution of attention and focus between the interface and the surrounding environment. Here, it would seem appropriate that the interface be designed so that, in some way, it *relates* to that environment.

Thirdly, the view is taken that in order that the walker/wanderer is able to gain a sense of orientation *in relation* to their surrounding environment (wherein their distribution of attention and focus is rebalanced), the interface's levels of content and interactivity would need to be greatly reduced. This would result in a much simpler interface than that presented by conventional examples.

Fourthly, and finally, with a simpler interface, it is anticipated that exploratory wayfinding might still be possible. That is, with less information and interactivity, walkers might be better positioned to 'discover' and 'find' on their own terms.

Gathering together these design propositions, we may say the following. A GPS-enabled WI, which is designed to visually support an *intrinsically* motivated urban recreational walker's/wanderer's situation awareness in use (SA-in-use)—while also ensuring that exploratory wayfinding practices are still possible—would

> *orientate the urban recreational walker in relation to their surrounding environment with minimal content and interactivity.*

The above statement may be understood as a formal, yet still *loose*, design hypothesis. Accordingly, it provides us with a useful focus from which a practical exploration of our framed area for experimentation may be launched. Returning to our diagram of the enquiry, we may note that we have now passed from the programme of semi-structured interviews to the position of holding a hypothesis.

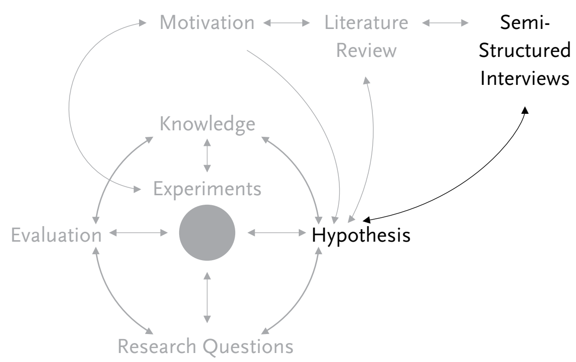


Fig. 4.10 The findings from the literature review and the interviews allow for the formulation of a simple hypothesis.

With this in place, it is now possible to move on to cover the second phase of the enquiry, wherein a series of design experiments were undertaken in response to the above hypothesis.

Summary

In this chapter we have discussed the results of the enquiry's first phase, wherein, a series of semi-structured interviews with urban recreational walkers/wanderers were conducted. The chapter was divided into three sections.

In the first section, participants' backgrounds were briefly outlined. Here it was noted that, participants were mostly aged between 25-34 and, geographically, were almost exclusively recruited from locations in Britain and Ireland. Further, in regard to the levels of frequency claimed by individual participants in relation to their practice of urban recreational walking/wandering, three general levels were seen to emerge: infrequent walkers, medium frequency walkers, and frequent walkers. Most were frequent walkers.

In the second section the results of the analysis were set out, wherein participants' responses to key questions were explored through the aid of a series of mappings. Here, participants' motivations to walk, their experience of exploratory wayfinding, as well as their use of wayfinding materials in general and GPS-enabled technology in particular were all considered.

With motivations, it was possible to group the basic themes into two simpler organising themes: *intrinsic* motivations and *extrinsic* motivations (see Section 4.2.1). Beneath these, three key themes were identified. Here, participants were frequently *intrinsically* motivated by the themes of *exploration* and *to see*, and *extrinsically* motivated by the theme of *exercise*.

In considering participants' experience of exploratory wayfinding it was possible to identify a number of *components* of the practice emerging from within the data. Here, two broad organising themes were identified: *tactical* components, and *experiential* components (see Section 4.2.2). In terms of *tactical* components the following were seen to emerge frequently: *taking emergent paths*, *directional movement*, *compelled by the immediate*, *linking to the familiar*, and *exploration*. Alongside these, the experiential component of *noticing* was also prominent.

With participants' use of GPS-enabled WIS, it was found that many did not use the technology. Some simply did not own a smartphone; others, however, held particular reservations regarding the use of GPS-enabled WIS. In regard to those who *did* use the technology, it was possible to identify a number of prominent priority-use themes. Here, participants were found to use such interfaces for support in: *orientation*, *navigation*, *planning* and *checking*. Of these, *orientation* emerged most prominently. When participants discussed what they percieved to be the deficits of GPS-enabled technology, the most prominent themes identified relating to the *experiential* aspects of use were: *undermines situation awareness* and the *negation of exploratory wayfinding* (see Section 4.2.6).

Finally, in the third section, against the above results of analysis, an area for experimentation was framed and, from this, a design hypothesis was formulated. The hypothesis states that: a GPS-enabled WI, which is designed to visually support an intrinsically motivated urban recreational walker's/wanderer's situation awareness in use (SA-in-use)—while also ensuring that exploratory wayfinding practices are still possible—would

> *orientate the urban recreational walker in relation to their surrounding environment with minimal content and interactivity.*

Endnotes

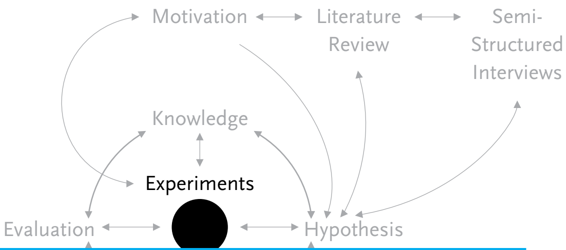
1. IP#22 was recruited through social media and her profile appeared to suggest that she engaged in urban recreational walking. However, in interview she revealed that her primary interest was urban photography, which was enabled by walking. IP#30 did not walk recreationally in urban environments, and was not interested in doing so. Instead, his focus was entirely rural.
2. This aligns with work undertaken by Lynch (1960), as well as Mollerup's notion of 'aiming' (2005) as a wayfinding strategy.

5. Design Experiments

Having set out the results of the enquiry's first phase in the last chapter, this chapter provides an overview of the enquiry's second phase. Herein, a series of design experiments were undertaken in order to develop a *novel* wayfinding interface (WI) in response to the design hypothesis of the first phase. The two initial sets of experiments—the exploratory designs and the field simulation test—were generative, i.e. a development cycle was pursued. From this, a mixed-fidelity working prototype was designed and trialled through the application of qualitative and quantitative methods of data collection and analysis.

The chapter is divided into four sections. In first section, the steps taken prior to the launch of the design experiments are discussed. In the second section, the results of the exploratory designs are presented. From this, the third section outlines the results of the field simulation test. Finally, in the fourth section, the design of the mixed-fidelity working prototype is described. From this, the qualitative and quantitative results of the test are set out.

A diagrammatic overview of the design experiments is presented below (figure 5.1).



The design hypothesis of Chapter 4,
informs the launch of:

A series of design experiments.

After the selection of a test platform (i.e. Apple's iPhone 4s) and preliminary design work (i.e. sketching) we move on to:

The Exploratory Designs

In the exploratory designs 3 arrays of alternative designs are developed in relation to three areas of focus:

The graphic space;
The representation of landmarks;
The you are here representation.

These are then shown to participants to informally test their semantic accessiblity.

The designs are carried into the:

The Field Simulation Test

The exploratory design informs a first field simulation design.

Participants evaluate the design, which leads to the iteration of the design. In this way, through the input of the 15 participants, 7 field simulations are developed.

In the test, participants are issued with two orientation tasks: one for Google Maps, one for the field simulation. In analysis their interface-environment interactions for both are compared.

Observing that participants appear to appreciate the essential features of the design, and that they are looking up more and turning their bodies more with the field simulations, the decision is taken to move onto design a prototype.

The last field simulation design informs the prototype design.

The Prototype Test

In the test, participants are issued with one orientation task for Google Maps. Then, they are asked to walk along a path and use the prototype at least twice by pressing a button. In analysis, their interface-environment interactions for Google act as a contrasting baseline profile against which their interface-environment interactions with the prototype may be considered.

Participants are interviewed in relation to what happened in their use of the prototype (i.e. their experience with the prototype) as well as what they felt both interfaces were 'like' (i.e. their experiences of each interface).

21 participants take part.

Fig. 5.1 A diagrammatic overview of the design experiments.

5.1 Commencing the Design Process

Prior to the launch of the design experiments, two initial steps were taken. Firstly, a test platform was selected. Secondly, a body of sketch work was produced. We will now consider each of these areas in turn.

5.1.1 *Selecting a Test Platform*

In this enquiry GPS-enabled WIS were designed specifically for use on handheld digital mobile telephones. Thus, for the purposes of consistency, it was necessary to identify a particular handheld mobile telephone on which to present the interface designs. In the end the Apple Corporation's iPhone 4S was selected as the enquiry's test platform. This selection was based on the wide availability and popularity of the device in the UK at the time of the research. As such, it was assumed that most participants would be familiar with both the screen size, as well as its basic functionality.

It will be informative to detail the technical specifications of the iPhone 4S, as these will provide us with an on overview of its capabilities. The display measures 640 pixels (px) wide by 960 px high. While this is not particularly large, interface designs on handheld mobile telephones are often constrained by relatively small screen sizes (Ballard 2007:74). Further to this, the iPhone 4S offers a resolution of 326 pixels per inch (ppi). It is also touchscreen and as such has no keyboard. Beyond the above, the iPhone 4S contains several sensors including a magnetometer, a three-axis gyroscope, and an assisted GPS (AGPS) receiver (Apple 2012).

These last three sensors are of particular interest within this enquiry: the magnetometer because it logs the orientation of magnetic north; the three-axis gyroscope because it measures the device's rotational movement along a three-axis plane; and lastly, the AGPS receiver because it allows for the rapid identification of the device's geographic coordinates. With data combined from these three sensors it is technically possible to present graphic representations which simultaneously reference the orientation of magnetic north, respond to the device's movements, as well as its geographic coordinates.

From the above identification of a test platform, preliminary design work began.

5.1.2 *Sketching a Preliminary Approach*

In preliminary design work a large body of sketches were produced. Through this process, five features were seen to converge. These included the application of:

- a distorted graphic space focusing on the user's location;
- linear graphic space focusing on the user's forward path;
- landmarks:
- the you are here representation;
- and the exclusion of streets and roads.

These features, their characteristics and the reasoning underpinning their convergence is set out on the below table.

The Convergent Features in the Early Sketch Work

Feature	Characteristics	Reasoning Underpinning the Convergence
Distorted Graphic Space Focusing on the User's Location	A form of distorted metric space, wherein the walker's/wanderer's position is privileged at the centre of the screen.	It was intended that an interface, which represented the walker's/wanderer's position as central, might allow the walker/wanderer to relate to the surrounding environment in orientation as they interpreted the directions of features from the perspective of their embodied position. Based on the idea that the user would see what was 'around', this was seen to align with Husserl's notion that the body imposes its own orientational framework (1981/1932, see Section 2.3.1).
A 'Linear' Graphic Space Focusing on the User's Forward Path	A form of distorted metric space, wherein the walker's/wanderer's 'forward path' is privileged on screen.	It was intended that an interface, which offered a representation of the walker's/wanderer's 'forward path', might allow the walker/wanderer to relate to the surrounding environment in orientation as they held the mobile phone up in a particular direction of travel in order to gain a sense of what was ahead. Based on the idea that the user would see 'ahead', this was seen to align with Husserl's notion that the body imposes its own orientational framework (1981/1932; see Section 2.3.1).
Landmarks	Cultural and geographic features are highlighted through graphic objects.	It was intended that the inclusion of landmarks might rapidly support a walker/wanderer in orientation. This belief arose due to most semi-structured interview participants having identified landmarks as their preferred map feature (see Section 4.2.3.1), as well as a key environmental resource they drew upon in wayfinding (see Section 4.2.3).

Feature	Characteristics	Reasoning Underpinning the Convergence
You are Here Representation	The walker's/wanderer's position is highlighted through a highly visible representation.	It was intended that the highlighting of the walker's/wanderer's position might rapidly support a walker/wanderer in orientation. This belief arose due to many semi-structured interview participants having identified the you are here representation as a useful map feature (see Section 4.2.3.1).
Streets and Roads Excluded	Streets and roads are excluded from the design.	It was observed that the exclusion of streets and roads would reduce the interface's overall content levels. The view was taken that this might allow for the practice of exploratory wayfinding (see Section 2.3.2.1), while also ensuring that orientation was still possible (through the inclusion of landmarks and the you are here representation, see above).

Table 5.1 The above table sets out the features which were seen to converge in early design work. Focus is directed to their characteristics and the reasoning which was seen to underpin the convergence.

The below series of figures present some of the sketches which led to the above series of convergences.

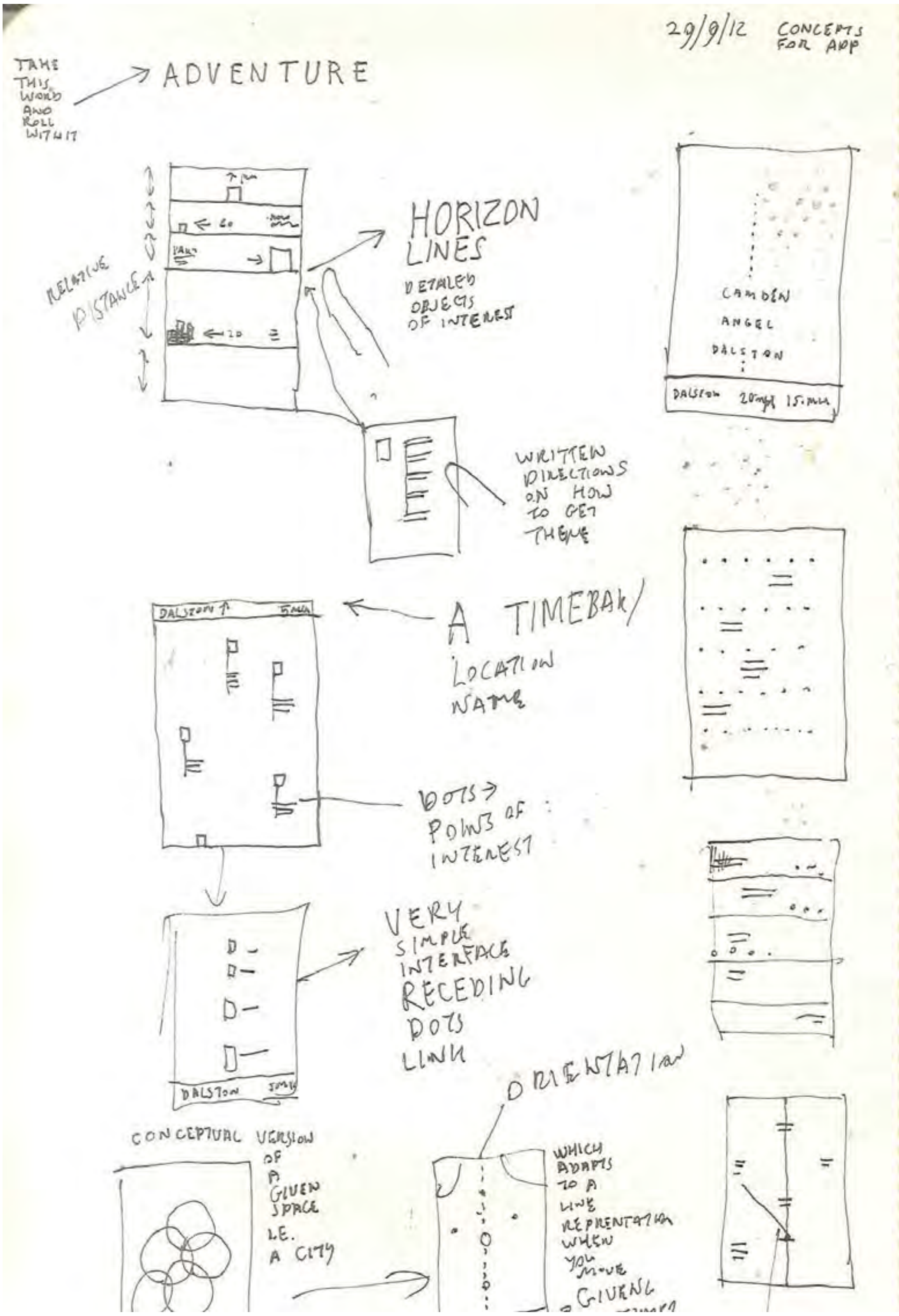


Fig. 5.2 A page of early sketches relating to possible forms the forward path design might have taken. In many examples the path is implied in the line-ups of graphic objects within each rectangle. In the top left rectangle, lines are used to suggest distance thresholds, i.e. how far something is. Objects have been placed on these lines to indicate their position at this distance. Many of the other examples take a similar approach. Notice that landmarks are drawn as simple shapes or points.

Fig. 5.3 An early sketch showing a 'forward path' design. Here, forward points and landmarks are shown as simple shapes and the walker's/wanderer's previous route is set out in the lower half of the screen.

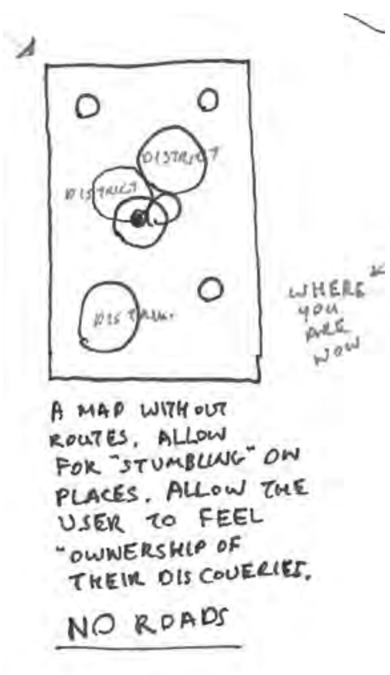


Fig. 5.4 An early sketch showing an egocentric design. Here the walker's/wanderer's position is displayed at the centre of the screen. City districts are denoted by the larger circles, which appear around this. It will be noted that no streets or roads are shown in this design.

We have thereby described the early design work and set out the list of convergent features that were seen to emerge therein. We will now move on to consider the first set of experiments, the exploratory designs.

5.2 The Exploratory Designs

The exploratory designs allowed for the rapid development of possible interface designs containing the features that were seen to converge within the preliminary design work. Herein, three separate experiments were conducted through the application of abductive reasoning (i.e. the application of imaginative thinking on the part of the researcher; see Section 3.3.6.1). Once complete, the results of these experiments were then presented to participants in order that the *semantic accessibility* of the designs might be tested (see Section 3.3.6 for a detailed outline of the method).

In the following sections, the parameters of the exploratory design work will first be defined. Then the process of applying abductive reasoning in each test will be described. Lastly, a brief reflection on presenting the exploratory designs to participants will be offered.

5.2.1 *The Parameters of the Exploratory Design Work*

Based on the five features that were seen to converge in sketching (see table 5.1 above), three areas of focus were identified within the exploratory design work: types of graphic space, landmarks and the you are here representation.

In attending to these areas, an array of *alternative* designs were produced. Here, Elias and Paelke's scale of 'levels of abstraction' (2008; see figure 5.5 below and Section 2.3.5) was appropriated as a tool that might guide the generation of alternatives[1]. Thus, once complete, each array could be seen as a suite of *logically related* but obviously distinct designs; as figure 5.1 below demonstrates.

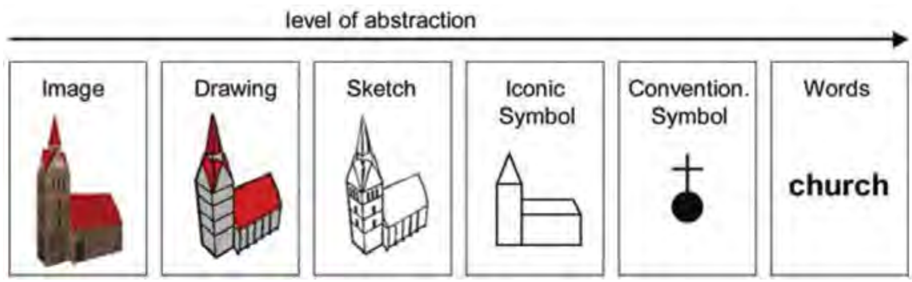


Fig. 5.5 Elias and Paelke's scaled level of abstraction (2008) as originally presented. The scale is seen to move from highly realistic (i.e. photographic images) to highly abstract (i.e. words).

Further to the above, two additional decisions were taken. Firstly, streets and roads were excluded from all designs. The thought here being that this exclusion might then be informally tested when the designs were presented to participants. Secondly, rather than six alternatives as is presented in the above scale, it was decided that four designs would allow for a sufficient exploration of alternatives. Here, detailed content-rich options were avoided in order to ensure that the interface contained minimal content as was proposed in the design hypothesis (see Section 4.3).

Having defined the parameters of the exploratory designs, it was then possible to develop each particular array through the application of abductive reasoning.

5.2.2 *The Results of Applying of Abductive Reasoning within the Exploratory Designs*

In order to define the scope of each array, the researcher applied *abductive reasoning* (Roozenburg 1993; see Section 3.3.6.1). That is, through imaginative thinking, practical outcomes were devised and, so, the process of arriving at definite *designed* forms was negotiated. Herein, building on the earlier sketch work the researcher defined a starting point and envisioned alternatives options from that point.

The below table provides an overview of the results of this process; identifying the alternative concepts which were generated across each array.

An Overview of the Exploratory Design Work

Area of Focus	First Alternative	Second Alternative	Third Alternative	Fourth Alternative
Types of Graphic Space (See Fig. 5.6)	A distorted metric space based on an imagined user's 'forward path'.	A distorted metric space focusing partially on the user's path (i.e. the user's location is foregrounded).	A distorted metric space with aspects of a path design (i.e. bars appear at the top of the interface indicating a direction).	A distorted metric space, focusing on the user's location.
Landmarks (See Fig. 5.7)	Highly-realistic literal correspondence (i.e. isometric buildings).	Semi-realistic literal correspondence (i.e. flat 2-D representations).	Abstract shapes (i.e. abstract representations such as circles and squares).	Text.
You are Here Representations (See Fig. 5.8)	A small conventional you are here representation containing a graphic object.	A 'flashlight' design inspired by the work of Aretz (1991).	A block-like representation containing a graphic object.	A large abstract circular shaped you are here representation containing a pictorial representation of a landmark.

Table 5.2 An overview of the approach applied in each of the alternative designs contained within the exploratory design array (i.e. landmarks, types of graphic space, and the you are here representations).

Below the exploratory designs are set out within their respective array.

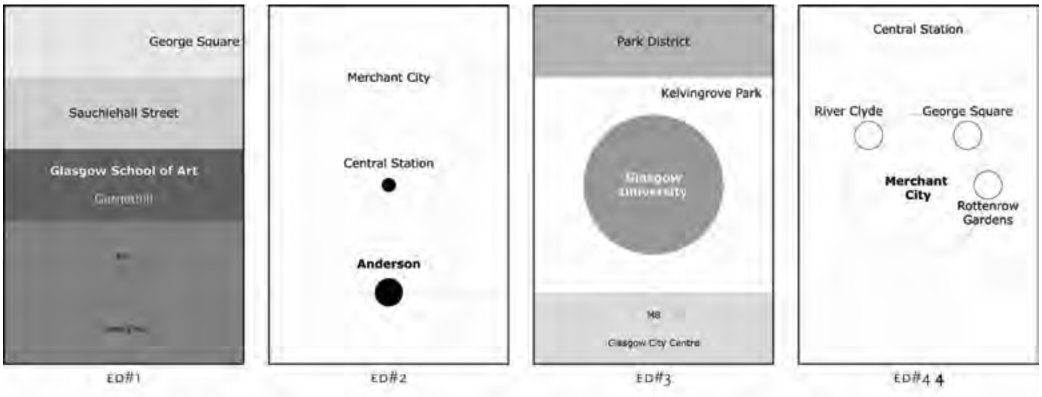


Fig. 5.6 Exploratory designs (EDs) for the type of 'graphic space' applied in the interface. Here, ED#1 presents a simple 'forward' path design, based on bars; ED#2 presents a less obvious 'forward' path design, with emphasis placed on the user's location through a large circle; ED#3 presents an egocentric design with bars denoting ahead and behind; ED#4 presents a simple egocentric design.

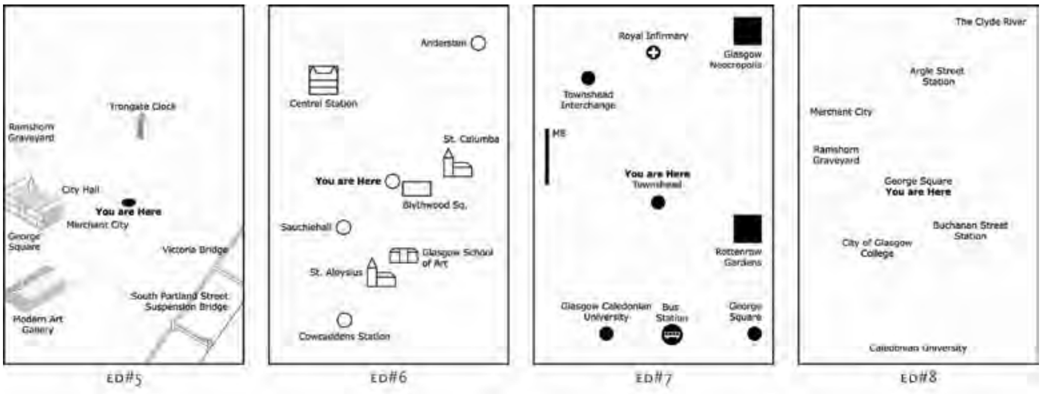


Fig. 5.7 Exploratory designs dealing with landmark representation. Here, ED#5 presents a highly-realistic literal correspondence; ED#6 presents a less realistic approach (i.e. flat 2-D landmarks); ED#7 presents abstract shapes, i.e. circles and squares; and lastly ED#8 presents text.

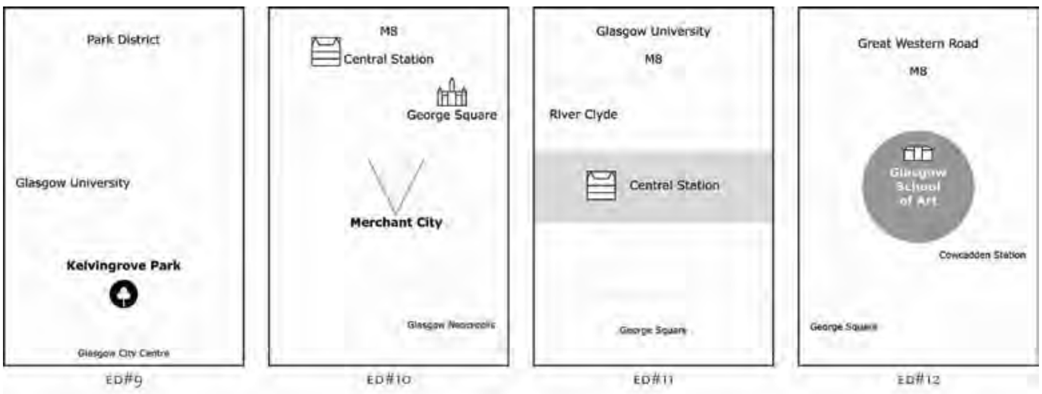


Fig. 5.8 Exploratory designs for the you are here representation. Here, ED#9 shows a simple black circle with a pictorial object; ED#10 employs a 'flashlight' design inspired by Aretz (1991); in ED#11 the walker's/wanderer's position is denoted by a highlighted bar; and, lastly, ED#12 presents a large circle with an inset pictorial representation of a landmark denoting the walker's/wanderer's position.

Once the exploratory design experiments were complete the three resultant arrays were shown to participants in order that the semantic accessibility of the designs might be informally tested.

5.2.4 A Reflection on Presenting the Exploratory Designs to Participants

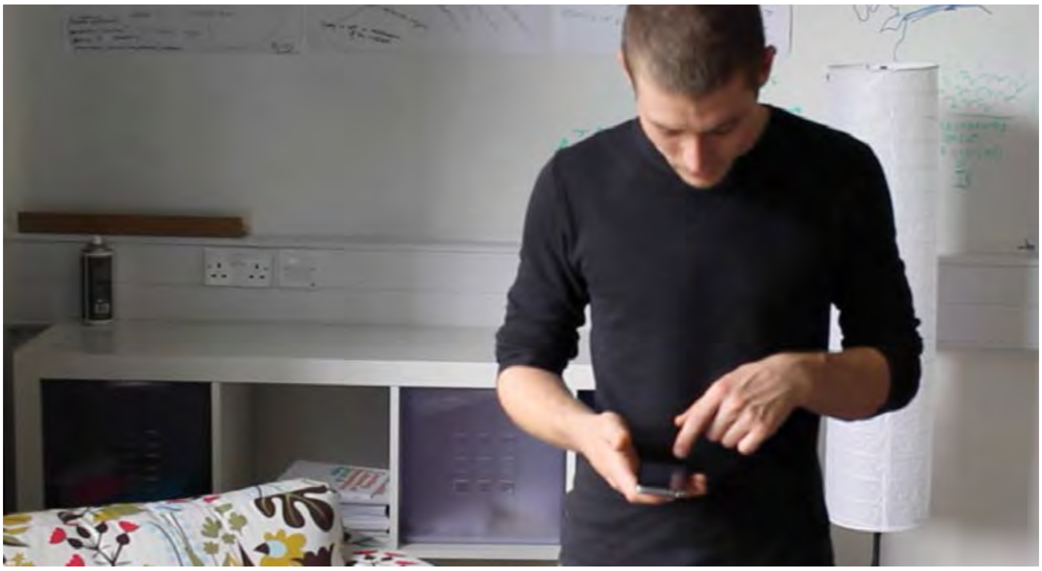


Fig. 5.9 The exploratory designs being presented to a participant on a mobile telephone screen for their consideration. Herein they were asked to tell the researcher what was 'around' based on the information presented on screen. Thus, the semantic accessibility of the designs were informally tested.

In total, the arrays were presented to ten participants. Six participants looked at the landmark array, and two participants each looked at the types of graphic space and you are here representation arrays. All presentations took place in quiet, naturally lit settings, which were *not* represented on screen. This latter decision rested on the belief that if participants were informed of the disconnect, their focus would be directed solely toward the design. Thus, while a wholly decontextualised setting was avoided, so too were the standard difficulties in defining test-conditions in field settings, e.g. unforeseen interruptions (Endsley 2012:55).

In viewing the arrays, all participants were able to draw meaning from the designs presented. Interestingly, the exclusion of streets and roads did not appear to hinder the *semantic accessibility* of any of the designs, as participants were generally able to quickly identify the location presented on screen. Further, even without streets and roads they were often able to relate particular experiences they had within the locations represented.

Despite this apparent ease of interpretation, some features did however cause difficulty. In particular, the more-realistic pictorial representations of landmarks appeared to confuse a number of participants as the landmarks' isometric angle was seen to suggest a different orientation than that upon which the representation was based on.

On occasion, without solicitation, participants were inclined to offer criticism and express preferences in regard to the array of alternatives that had been presented. However, as this data was unstructured (i.e. no interview guide was applied) and incomplete (i.e. not all participants contributed), it was decided not to analyse these criticisms and preferences. Instead, the researcher reflected upon the exploratory designs and sought to reapply those features, which were deemed to hold the most potential, in the field simulation test.

5.3 The Field Simulations

In the field simulation test, *simulated* interface designs were trialled in 'natural' settings of use, i.e. in outdoor urban locations in the city of Glasgow. In the following sub-sections we first turn our attention to the selection and reapplication of the exploratory design features within the opening field simulation (FS) design. Next, an outline of participants' reported walking practices is provided. Then, the parameters of the test are described. Lastly, we discuss the qualitative and quantitative methods of data collection and the results of analysis of this data.

5.3.1 *Selecting and Reapplying Exploratory Design Features in a First Field Simulation Design*

Lining up each array produced in the exploratory designs, allowed the researcher to perform a close comparison of the features presented in each. Through this activity, it was possible to select and isolate those features were seen to hold potential, i.e. might contribute to an appropriate practical realisation of the design hypothesis (see Section 4.3). Thus, tentative selections were made in relation to the *type* of graphic space, the representation of landmarks and the you are here representation.

On the one hand, these selections were based the researcher's preferences, i.e. what was *perceived* to hold potential as features which might contribute to an appropriate practical realisation of the design hypothesis. On the other, technical constraints were attended to. Here, the researcher asked what was *technically* possible. Thus, through the imposition of internal, *designer-imposed* constraints (Lawson 2006/1980:93), a number of straightforward design decisions were made.

The below table highlights the particular designs that were selected for reapplication from each of the exploratory design arrays.

The Particular Exploratory Designs Selected for Reapplication

Area of Focus	First Alternative	Second Alternative	Third Alternative	Fourth Alternative
Types of Graphic Space (See Fig. 5.6)	A distorted metric space based on an imagined user's 'forward path'.	A distorted metric space focusing partially on the user's path (i.e. the user's location is foregrounded).	A distorted metric space with aspects of a path design (i.e. bars appear at the top of the interface indicating a direction).	A distorted metric space, focusing on the user's location.
Landmarks (See Fig. 5.7)	Highly-realistic literal correspondence (i.e. isometric buildings).	Semi-realistic literal correspondence (i.e. flat 2-D representations).	Abstract shapes (i.e. abstract representations such as circles and squares).	Text.
You are Here Representations (See Fig. 5.8)	A small conventional you are here representation containing a graphic object.	A 'flashlight' design inspired by the work of Aretz (1991).	A block-like representation containing a graphic object.	A large abstract circular shaped you are here representation containing a pictorial representation of a landmark.

Table 5.3 An overview of the designs which were selected for reapplication from each of the exploratory design arrays. The designs which were selected are shown in black, while the rest are shown in grey.

Based on the above, it will be noted that the researcher selected the following designs for reapplication:

- a distorted graphic space focusing on the user's location;
- semi-realistic representation of landmarks involving a literal correspondence;
- a large abstract circular-shaped you are here representation.

The reasons for these selections are detailed on the below table.

Reasons for the Selection of Particular Exploratory Designs for Reapplication

Design Selected from the Exploratory Designs	Reason(s) for Selection	Possible Alignment(s) with the Design Hypothesis (see Section 4.3)	Reason(s) for the Rejection of Other Options
Semi-realistic Literal Correspondence (i.e. flat 2-D representations)	This design was seen to allow for a minimal, yet sufficient, level of representational detail.	May allow the walker/wanderer to relate to the surrounding environment through the provision of minimal content.	The more realistic designs (i.e. the isometric buildings) were seen as unnecessarily detailed and possibly confusing.
A Distorted Graphic Space Focusing on the User's Location	This design was seen to privilege the walker's/wanderer's position from a holistic perspective, wherein all directions were presented and not just a single direction. Accordingly, it was felt that it would offer the most potential as a visual approach to support orientation.	May support the walker's/wanderer's orientation.	The linear designs based on the walker's forward path were seen as limited in that the areas to the right and left of the walker were not represented. Equally, the technical feasibility of this option was in doubt.
A Large Abstract Circular-Shaped You are Here Representation	This design was seen as highly impactful and instantly accessible. Accordingly, it was felt that it would offer the most potential as a visual approach to support orientation.	May support the walker's/wanderer's orientation when set against other features (i.e. landmarks).	The other representations were not seen to offer the same potential as a visual approach to supporting orientation. The 'flashlight' design inspired by the work of Aretz (1990), was given consideration but in the end was seen to lack the visual impact of the larger representation.

Table 5.4 An overview of the reasons for the selection of particular alternatives over others, as well as the possible alignment(s) with the design hypothesis.

In order to synthesise and so *reapply* the above designs, a series of sketches were produced. Here, over several sketchbook pages, an incremental exploration of the interface's configuration was undertaken. Within this process, the notion of making a distinction between 'near' features (i.e. those features which proximate to the user) and 'far' features (i.e. those features which were distant from the user) was conjectured. The sketchbook page wherein the final approach was arrived at is shown below in figure 5.10.

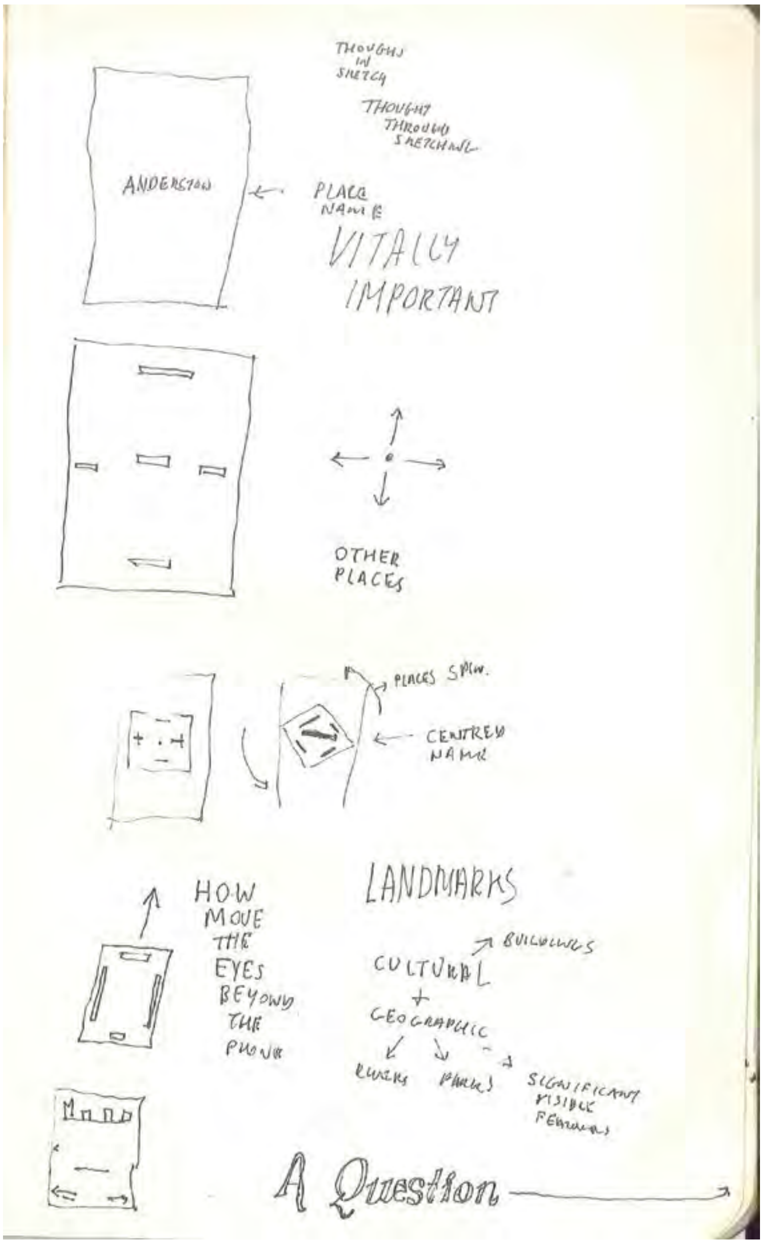


Fig. 5.10 A sketchbook page whereon the structure of the first FS design was scoped out. Here, from top to bottom, the researcher decided to: focus on the user's location through the provision of centred text; to offer the user's orientation through the placement of information at the edges of the screen; and thereafter, on the lower half of the page, to enable the rotation of the screen such that the edge-information would hold orientation with 'real' world objects.

From this synthesis process, the first FS design was developed for a particular test site in central Glasgow. The site, on a busy shopping street, was chosen on the basis that it contained two long 'vistas' (Gibson 1986/1979; see Section 2.3.2), as well as several proximate landmarks (Lynch 1960; see Section 2.3.2).

In order to populate the interface, the most *significant* proximate landmarks[2] were identified and a set of graphic objects was produced to represent these. (For an outline of the reasoning underpinning the selection of particular landmarks, the reader is advised to the turn to the captions appearing under the map figures in Section 5.3.4).

Next, the interface was programmed to *rotate* in accordance with the data drawn from the iPhone 4S's sensors so that it functioned like a working compass. That is, the graphic objects held orientation towards sites in the 'real-world'. In the two figures below, we see the first complete FS design (figure 5.11) set alongside a map of the test site (figure 5.12).

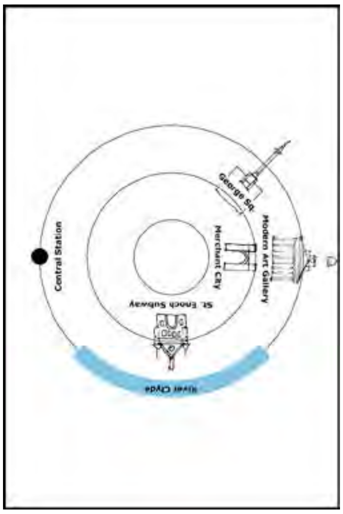


Fig. 5.11 The first FS design, FS#1. The user's location is denoted by the middle circle. The blue line denotes the river Clyde, while the landmarks are positioned according to the angle at which the user might face them. There is no literal correspondence in regard to distance ratios, i.e. the metric representation of distance.

Fig. 5.12 The site chosen for FS#1 was in the middle of Buchannan Street; a long, central shopping street. Participants would have seen the stone arch, as well as the Museum of Modern Art beyond it. Both of these sites were selected for inclusion on the basis that they were visible and sizable. The additional non-visible landmarks (i.e. George Square, the Enoch Subway station, Central Station and the river) were selected on the basis that they were seen as significant and were no more than a kilometre distant (Adapted from Openstreetmap 2015c).

With the first FS design complete, it was necessary to recruit participants to take part in the test process.

5.3.2 *The Walking Practices of the Participants Recruited within the Field Simulation Test*

In total, fifteen separate participants were recruited within the course of the field simulation test. As in the programme of semi-structured interviews, recruitment proceeded through a combination of purposive and snowballing sampling (see Section 3.3.3). The majority of participants claimed to engage in urban recreational walking/wandering. However, as a result of the application of snowball sampling (i.e. where participants are recruited on the recommendation of previous participants), it transpired that a number of participants were *not* likely to engage in urban recreational walking/wandering. Despite this, their contributions have been retained on the basis that they present an informative contrast to those who *do* engage in urban recreational walking/wandering.

5.3.3 *The Field Simulation Test*

Fig. 5.13 A participant taking part in the field simulation test, with the first FS design, FS#1. As she points, she is telling the researcher what was 'around' her based on the information presented on the mobile telephone screen. In this way, participants' behaviours were observed and they were able to experience the interface such that it could be openly evaluated.

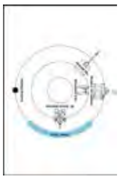
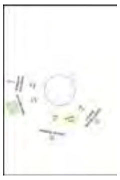
The field simulation test was divided into two parts. First, participants were issued with an orientation task, wherein Google Maps was used. Then, in the second part, they were issued with another orientation task with a FS design. In these tasks, the participant was asked to tell the researcher what was 'around' based on the information presented on screen. In data collection and analysis, focus was directed towards the qualitative aspects of participants' experience of the FS design in relation to the surrounding environment. Thus, at the end of the test, participants were asked to *openly* evaluate the interface.

In addition to this, through observation, attention was also paid to their interface-environment (I-E) interactions, i.e. to where they looked and how they moved. A comparison was then made between the I-E interactions observed for Google Maps and those observed with the FS design. In order to facilitate this process, the whole test was videoed. (See Section 3.3.7 for a detailed outline of method).

5.3.4 *The Results of the Participants' Open Evaluations of the Field Simulation Designs*

In analysing participants' open evaluations at the end of each field simulation test it was possible to code their feedback into extracts which were seen to reference either positive or negative aspects. In considering the negatives it was necessary to return to the design hypothesis and the results of analysis of the interviews (i.e. the data of the enquiry's first phase), to judge whether or not the feedback was relevant. That is, whether or not it aligned with the design's point of origin. If the feedback was judged to be relevant, an attempt was then made to *respond* in a subsequent *iterated* design through abductive reasoning (see Section 3.3.6.1). Herein, the interface was *redesigned* or *adapted* in such a way as to move beyond that which had been negatively evaluated or misinterpreted. Table 5.5 below provides an overview of how this process advanced. Small thumbnails of the FS designs are included alongside the data collected in relation to each. Larger images of the FS designs follow the table.

The Results of the Open Evaluations and the Subsequent Abductive Response Taken

The FS Design and the EPs Involved	Positive(s) Identified in Participants' Open Evaluations	Negative(s) Identified in Participants' Open Evaluations	Subsequent Abductive Response
FS#1  EP#1, EP#2, EP#3, EP#4, EP#5	EP#1, EP#2, EP#3 all appreciated the inclusion of cultural landmarks EP#1, EP#2, EP#3 all appreciated the directionality of the interface (i.e. the compass based design). EP#2 and EP#5 both appreciated the minimal level of content. EP#2 appreciated the use of colour for the river.	EP#1 was confused as to whether the 'rings' within the design represented actual, set distances or were simply arbitrary. EP#3 and EP#4 were confused as to which of the landmarks represented were 'immediately' visible and which were not. It was inferred that this problem was due to a single 'type of correspondence' (Engelhardt 2002:97) being applied within the design, i.e. a literal representation. That is, visible landmarks were not differentiated from those which were out of sight. EP#4 objected to the circular design and the exclusion of streets.	'Pointing lines' are introduced, linking landmarks to the you are here representation. The lines indicate direction at the same time as containing a 'declaration' of the time it would take to arrive at the specific landmark. Visual distinctions are made between visible and non-visible landmarks. Visible landmarks are represented with a literal shape. Non-visible landmarks are represented with abstract shapes (e.g. a circle).
FS#2  EP#6	EP#6 appreciated the directionality of the interface.	For the designer and EP#6 it was felt that the type of correspondence applied to the 'visible landmark' was not literal enough for it to be recognisable as a visible landmark within the environment. EP#6 appeared to understand the 'pointing lines' as a rigid set of directions rather then simply an immediate orientational overview.	'Pointing lines' linking landmarks and the you are here representation are minimised. 'Literal' representations of landmarks are avoided. A new you are here representation is designed: an arrow-like representation of the street location (i.e. Vincent St.).
FS#3  EP#7	EP#7 appreciated the directionality of the interface (i.e. the compass based design). EP#7 appreciated the minimal level of content.	EP#7 could not identify the river (i.e. a blue line on the representation) as a river. EP#7 did not look up when verbally identifying the you are here representation (i.e. the arrow-like design) representing their position.	The you are here representation is deemphasised and made circular. The 'direction' of landmarks is emphasised, with large triangles pointing in the directions of landmarks, distributed around the outer edge of the design.
FS#4  EP#7	EP#7 appreciated the directionality of the interface (i.e. the compass based design). EP#7 appreciated the minimal level of content.	No significant negatives were identified. The triangles appeared to function successfully as a means of directing the participant's gaze.	Triangles were reapplied at the other edge. A coloured 'band' is included to indicate distance. 'Far' features are placed within it. The direction of the city centre is highlighted in the band.

The FS Design and the EPs Involved	Positive(s) Identified in Participants' Open Evaluations	Negative(s) Identified in Participants' Open Evaluations	Subsequent Abductive Response
FS#5  EP#8, EP#9, EP#10	EP#8 appreciated how the interface drew her into relation with the river. EP#9 appreciated the time-based indication of distance. EP#10 appreciated the minimal level of content.	EP#8 misidentified a graphic object representing a park as a 'point locator' identifying their position. They felt that this was due to the fact that it was set at a brighter colour than all the other graphic objects on screen.	The size of the you are here representation is increased so it is made clearer and more distinguishable. The coloured 'band' is removed, as it does not appear to have been impactful. Wedge-shaped sections of the band are retained, so as the direction of areas/districts may be represented.
FS#6  EP#11, EP#12	EP#11 appreciated the directionality of the interface (after some deliberation).	Both EP#11 and EP#12 appeared unable to recognise the you are here representation. While both EP#11 and EP#12 were looking up they appeared to struggle to make connections between the graphic objects that were appearing on screen and the features in the environment that these graphic objects were referencing. EP#12 objected to the exclusion of streets.	The size of the text applied in the labelling is increased to improve legibility. The literal representation of landmarks is reintroduced in response to the participants' apparent struggle to make connections between what was appearing on screen and features in the environment.
FS#7  EP#13, EP#14, EP#15	EP#14 and EP#15 both appreciated the directionality of the interface (i.e. the compass based design). EP#14 and EP#13 both appreciated the minimal level of content. EP#13 appreciated how the interface drew her into relation with features in the environment. EP#13 appreciated what she perceived to be the interface's simplicity. EP#15 appreciated the inclusion of cultural landmarks.	None of the participants appeared confused by the overall presentation. However, they did not appear to notice the variations in sizes which had been applied among the triangles, in order that distance be denoted (e.g. 'near', 'far').	A working mixed-fidelity prototype is developed in order to consolidate the insights from the field simulation test.

Table 5.5 The results of the open evaluations and the subsequent abductive responses which were taken. The FS number and associated participants are shown on the left. The positives, negatives and responses are then set out to the right.

From the above, the full sequence of iterated FS designs (i.e. those produced after the first design) are presented below, along with maps of the sites for which they were designed. In some cases, photographs of participants are also provided.

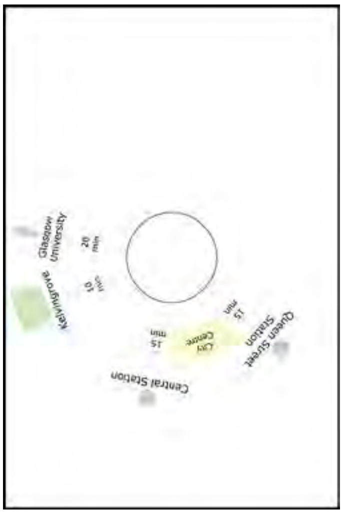


Fig. 5.14 The second FS design, FS#2. Here, lines link landmarks to the centre circle, which denotes the user's location. Declarations of time sit at the mid-point of each line, indicating how long it would take to walk to a particular site. Landmarks are represented through simple shapes, appearing on the outer edge.

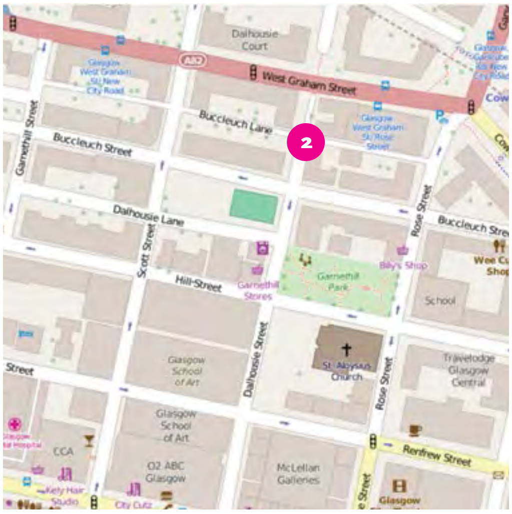


Fig. 5.15 The site chosen for FS#2 was a small street on the northern edge of the city centre. Participants would have seen the Glasgow University tower, which was selected for inclusion on the basis that it was visible and sizable. The additional non-visible landmarks (i.e. Kelvingrove Park, Queen Street Station, the city centre, and Central Station) were selected on the basis of their significance and the fact that they were little more than a kilometre distant. (Adapted from Openstreetmap 2015d).

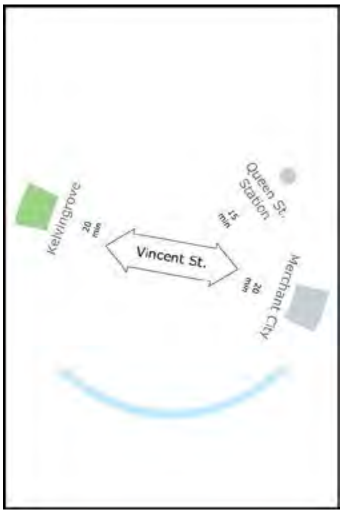


Fig. 5.16 The third FS design, FS#3. Here, the user's location is represented by the 'Vincent St.' bar with pointed ends. Lines link to landmarks, with declarations of time sitting at the mid-point on each line, indicating how long it would take to walk. Landmarks are shown as shapes and points on the outer edge.

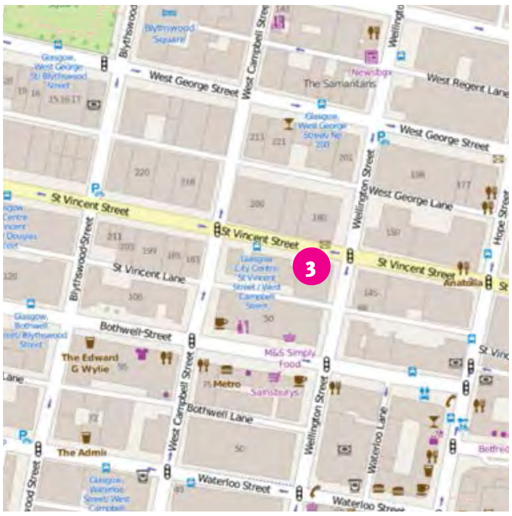


Fig. 5.17 The site chosen for FS#3 was on Vincent Street in the middle of the city centre; a long quiet street with few shops. Participants would not have seen any visible landmarks, though the abstract shape at the centre was meant to denote the street itself. The non-visible landmarks (i.e. Kelvingrove Park, Queen Street Station, and Merchant City) were selected on the basis of their significance and the fact that they were little more than a kilometre distant. (Adapted from Openstreetmap 2015e).

Fig. 5.18 The fourth FS design, FS#4. Here, the user's location is denoted by the middle circle. A nearby park is denoted by the green square. Around the edge, we see a river represented by a blue line and the direction of districts denoted by triangles.

Fig. 5.19 The site chosen for FS#4 was in the middle Glasgow's west end, at the top of Byres Road. Across the road, the participants would have seen the entrance to Glasgow's Botanic Gardens, which was selected because of its significance as a recreational site. The additional non-visible landmarks (i.e. Kelvingrove Park, the city centre and Partick) were selected on the basis of their significance as districts in the city and due to the fact that they were little more than a kilometre distant. (Adapted from Openstreetmap 2015f).

Fig. 5.20 EP#7 looks up from the interface, towards Glasgow's botanic gardens across the street, while using FS#4.

Fig. 5.21 The fifth FS design, FS#5. Here, the user's location is denoted by the middle circle. A nearby park is denoted by the green square. Around the edge, representing distance we see a grey band. The direction of districts are represented in the band with small triangles.

Fig. 5.22 The site chosen for FS#5 was on the western edge of the city centre. Up the road, participants would have seen Blythswood Square, which was selected on the basis of its significance as a recreational site. The additional non-visible landmarks (i.e. Kelvingrove Park, the city centre, and the river Clyde) were selected on the basis of their significance as districts or landmarks and the fact that they were little more than two kilometres distant. (Adapted from Openstreetmap 2015g).

Fig. 5.23 EP#9 looks up from the interface, towards nearby Bath Street, while using Google Maps.

Fig. 5.24 The sixth FS design, FS#6. Here, the user's location is denoted by the large middle circle. Around the edge, large and small triangles appear, representing the direction of particular features. A district is denoted through a large wedge, which contains a triangle and text.

Fig. 5.25 The site chosen for FS#6 was on the north western edge of the city centre at St George's Cross; the site of a subway stop and the beginning of Great Western Road. Participants would have seen Great Western Road, selected for inclusion on the basis that it was visible and is seen to be a significant 'path' in the city (see Lynch 1960; Section 2.3.2). The additional non-visible landmarks (i.e. Kelvingrove Park, the river Clyde and the city centre) were selected on the basis of their significance as an edge and city district; and the fact that they were little more than two kilometres distant. (Adapted from Openstreetmap 2015h).

Fig. 5.26 The seventh FS design, FS#7. Here, the user's location is denoted by the large middle circle. Around the edge, large and small triangles appear, representing the direction of particular features. One of these is seen to contain a pictorial representation of a landmark and as such represents the direction of this feature. A district is denoted through a large wedge, which contains a triangle and text.

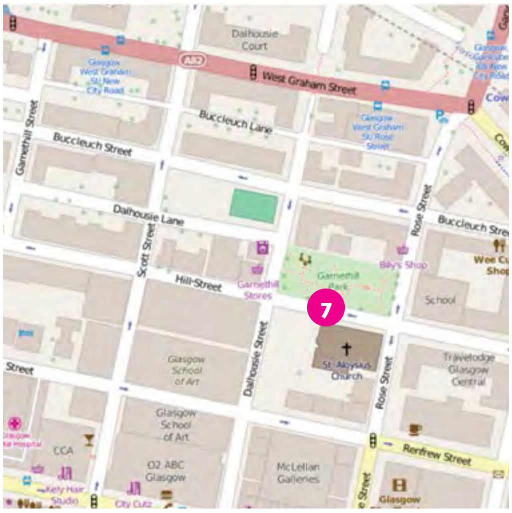


Fig. 5.27 The site chosen for FS#7 was on the northern edge of the city centre at Garnethill Park; a small intercity park near Glasgow School of Art. Participants would have seen the Glasgow School of Art, selected for inclusion on the basis that it was visible and very proximate. The additional non-visible landmarks (i.e. Kelvingrove Park, the city centre and the M8) were selected on the basis of their significance as city districts or edges (Lynch 1960; see Section 2.3.2) and were little more than two kilometres distant. (Adapted from Openstreetmap 2015d).

Fig. 5.28 EP#13 points in the direction of Glasgow School of Art as she uses FS#7.

Contextualising the above sites, a further map is presented below.

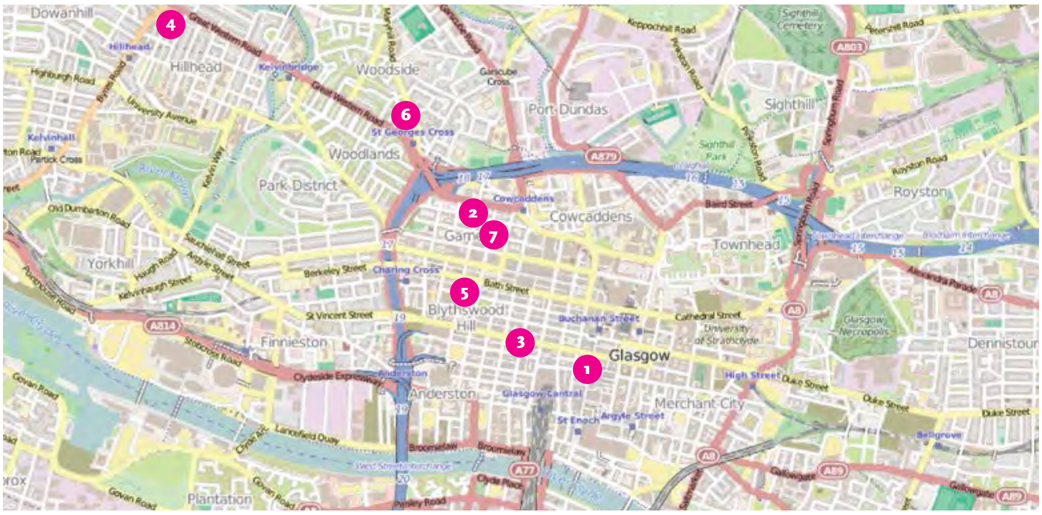


Fig. 5.29 The magenta dots highlight and number the sites for which the FS designs were developed in Glasgow's city centre and west end. There is no intended pattern to their distribution; rather the map shows the sites in relation to one another. (Adapted from Openstreetmap 2015a).

Having presented the iterated FS designs as well as mapped the test-sites, it is now worth highlighting some of the trends within the evaluations.

In terms of positive evaluations, several participants were seen to make reference to the directionality of the interface. Several participants also spoke positively about the interface's emphasis on cultural and geographic landmarks.

In terms of negative evaluations, three participants were seen to object to the direction-based design and/or the absence of streets within the representation. In these cases, participants spoke of the difficulties which might arise were they to use the interface in order to navigate *precisely*. EP#12, for example, noted plainly how, for her, the interface's exclusion of streets and roads was confusing:

> 'Well I think automatically you're a bit more confused. Because with the map you can see exactly where you are. Like, I'm always quite good at map reading. You know, when you can see that corner of the road and stuff. You know where you are on the map. If it was like compass-based, I'd be completely lost!'
>
> —EP#12

Further discussion with these negative case participants revealed that none was likely to engage in urban recreational walking/wandering. Accordingly, while their contributions have been taken into account, they are not seen as relevant to the context of the enquiry (wherein focus is directed towards the design of GPS-enabled WIs for urban recreational walkers/wanderers).

The above open evaluations were accompanied by an analysis of the observation data drawn from the video recordings of participants' behaviours in use. We will now turn to consider the results obtained here.

5.3.5 *The Results of the Analysis of the Observation Data*

For the purposes of observing participants' I-E interactions in their use of both Google Maps and the FS design, an *observation schedule* (Bryman 2008:273) was developed. Herein, focus was directed towards two particular behaviours, identified as significant.

The first related to the frequency of participants' upward glances/gazes, (i.e. how often they were seen to *look up* from the interface); as this was seen as indicative of the extent to which their attention was distributed between the interface and the environment. The second related to the way in which participants moved to orientate their body in use (i.e. if they turned to align themselves with the arrangement of the interface); such movements were seen to suggest that the participant had formed a *conceptual* link between their bodily orientation and the interface.

In observation, participants' use of each interface was sampled for one minute. Thereafter, each set of results (i.e. each individual's behaviour in their use of Google Maps and the FS design) were paired and grouped within a table, forming a *case series* (Farringdon et al. 1996). Through a simple case-by-case variance analysis (Robson 2011:459), it was possible to identify individual differences in performance. This, in turn, allowed for the observation of general trends across the series.

Before we turn to the results, it is important to draw attention to two issues regarding the data.

Firstly, several participants did not complete the task set within the second part of the test (i.e. they did not identify what was 'around' based on the information presented on screen). This was due to their insistence on entering into conversation with the researcher on being presented with the FS design. Here, it was possible to collect qualitative data (i.e. an open evaluation), but not quantitative data (as the task was not completed as requested). Consequently, in these cases, no variance analysis was performed.

Secondly, on a number of occasions, in presenting the first FS design to participants (i.e. participants EP#1 through to EP#5) the recording device failed to log a recording. As a result, no data was collected on these occasions and, again, it was not possible to perform a variance analysis here. All of these 'failed' cases are still *presented* below, but are not subsequently analysed or discussed.

The results of analysis are set out on table 5.6 below (including the above disparities).

Variance in Participants' Behaviour in Use in the Field Simulation Test

FS Design	EP No.	No. of Times Participants Looked Up in Use		No. of Times Participants Turned their Bodies in Use		Variation Result as it Relates to the FS Design	
		Google	FS	Google	FS	Looking Up	Body Turns
FS#1	EP#1	5	Recording failed	0	Recording failed	—	—
	EP#2	Recording failed	4	Recording failed	2	—	—
	EP#3	5	7	0	2	+2	+2
	EP#4	Recording failed	10	Recording failed	3	—	—
	EP#5	3	4	1	0	+1	-1
FS#2	EP#6	1	Did not complete task	0	Did not complete task	—	—
FS#3	EP#7	0	3	0	2	+3	+2
FS#4	EP#7	0	3	0	1	+3	+1
FS#5	EP#8	0	3	0	0	+3	0
	EP#9	8	11	2	5	+3	+3
	EP#10	7	4	0	0	-3	0
FS#6	EP#11	0	Did not complete task	0	Did not complete task	—	—
	EP#12	0	2	0	4	+2	+4
FS#7	EP#13	1	Did not complete task	0	Did not complete task	—	—
	EP#14	4	6	0	2	+2	+2
	EP#15	4	3	0	2	-1	+2
						Median Values Derived	
						+2	+2

Table 5.6 The above table shows the number times participants looked up, as well as the number of body turns they performed, while using Google Maps and the FS designs. From these, it presents the median variation between the two values across the series.

A number of observations may be made in regard to the above results. Firstly, turning to the variance in the number of times participants are seen to look up in each part of the test, we may note that—apart from two cases—all participants look up more often during the second part of the test (i.e. with the FS designs). Here, across the series, a median value of 2 additional upward glances/gazes with the FS designs was derived. Thus, we may say that participants were *more* likely to *look up* from the interface while using the FS designs, than Google Maps.

Secondly, turning to the variance in the amount of body turns performed by participants in each part of the test, we see that—apart from two cases —no participants altered their body's orientation in the first part of the test (i.e. with Google Maps). In contrast, almost all were seen to at least subtly alter their body's orientation in the second part of the test while using the FS designs. In fact, this occurred in all but two cases. Here, across the series, a median value of 2 additional body turns with the FS designs was derived. Thus, we may say that participants were *more* likely to *turn their body* while using the FS designs, than Google Maps.

From this, having produced seven FS designs, the researcher reflected on the results of both the evaluations and observations.

5.3.6 *The Transition Point between the Field Simulation Test and the Prototype Test*

Reflecting the results of evaluation and observation after FS#7, i.e. the last FS design, the researcher made three observations. Firstly, it appeared that, despite some objections (i.e. from three cases), the essential features of the FS designs appealed to many participants. That is, many participants expressed appreciation for the directionality of the interface, as well as its emphasis on cultural and geographic landmarks. Secondly, when comparing the levels of I-E interactions observed for both interfaces, the FS designs were performing better. That is, participants were seen to look up and turn their bodies *more* often while using the FS designs over Google Maps. Thirdly, it appeared that the structure of the latter FS designs had begun to converge. In other words, there were few discernable differences between FS#6 and FS#7.

Taken together, these three observations suggested that a satisfactory level of refinement had been reached. Accordingly, the view was taken, that in order to progress the research, a mixed-fidelity working prototype should be developed based on the structure of the final FS design (i.e. FS#7).

5.4 The Prototype

In the final design experiment—the prototype test—a mixed-fidelity working prototype was developed and trialled in a 'natural' setting of use, i.e. an outdoor test-route in the city of Glasgow. In the following sub-sections, we first move to discuss the design of the prototype. From this, participants' reported walking practices and levels of familiarity with the test-route are outlined. Then, the parameters of the test itself are described. Lastly, we discuss the qualitative and quantitative methods of data collection and the results of analysis of this data.

5.4.1 *Designing the Prototype*

In moving to design the prototype, the researcher first selected a test-route: a riverside path approximately one kilometre in length passing through a large park, known as Kelvingrove. This selection was made on the basis that the path provided a clearly defined test-route and brought the walker into proximity with many high-profile local landmarks including a museum, a university campus, and a river.

Fig. 5.30 The test setting highlighted in the context of the city of Glasgow. Glasgow city centre may be found to the right of this image, on the opposite side of the M8 motorway. (Adapted from Openstreetmap 2015a).

Fig. 5.31 The heavy pink line shows the path that participants were expected to follow as they advanced along the test-route: starting at the bottom and making their way towards the finish at the top. As they moved from start to finish they left a district called Finneston (at the bottom of the image), passed a district called Park Circus (on the right of the image) and ended near a district called Hillhead (at the top of the image). A number of prominent landmarks were visible along the way. These included Kelvingrove Museum, which is denoted by a pictorial representation of a museum in the bottom left of the map, and Glasgow University, denoted as the 'Gilbert Scott Building' on the middle right. (Adapted from Openstreetmap 2015b).

From this selection, a number of prolonged site visits were undertaken. Within these visits, the researcher sought to immerse himself in the surroundings and identify any salient features, which might be incorporated within the prototype interface. This technique was influenced by the Alison Barnes's notion of a 'geo/graphic' practice within graphic design (2011). Herein, drawing on ethnographic principles, Barnes proposes that graphic designers can legitimately position themselves as an interpreter of 'place' by walking through it and thereafter reflecting upon that experience (2011:209). Additionally, Kevin Lynch's system of 'elements' of the city image, i.e. paths, edges, nodes, districts and landmarks (1960:46; see Section 2.3.2), was employed as a framework for directing the interpretive process.

During each visit, the researcher paid particular attention to specific locations at which large, prominent buildings could be seen, as well as the city districts that the walker would be moving towards and away from. This resulted in the identification of a series of key landmarks, an edge, and a number of districts[3] for inclusion within the prototype interface.

An early sketch map, shown below, collects these elements together in an initial impression of the route.

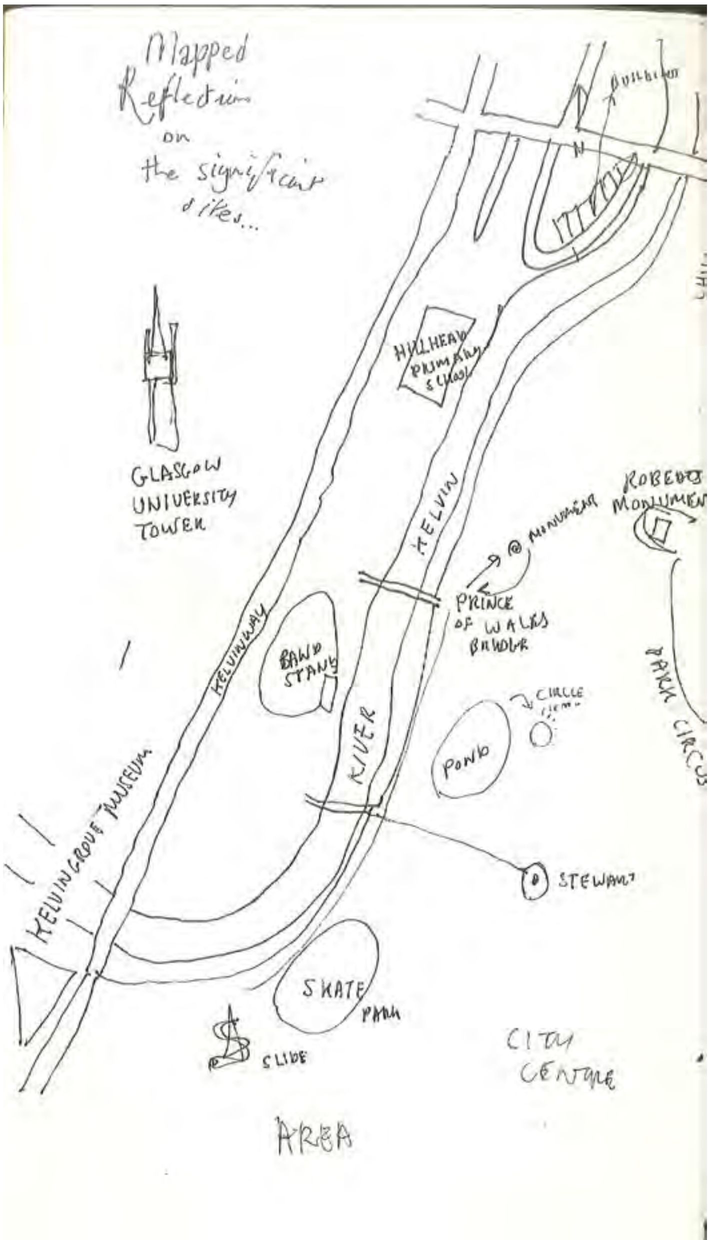


Fig. 5.32 A sketched map of the test-route, with what were then identified as the key landmarks, districts and edges along the test-route. Glasgow University tower was seen as particularly visible in the landscape, and as such is denoted by a profile sketch of a large tower.

The final master list of elements is offered on the below table.

Element Master List for the Prototype Test Site

Element Type	Items Identified (In order of their sequential appearance along the route)	Description
Landmark	Kelvingrove Museum	A large Victorian museum, situated near the start of the route.
	Glasgow University	A large gothic university building, with a very prominent tower. The tower can be seen from most points along the route.
	Stewart Memorial	A large Victorian fountain, with a small statue. The fountain is situated a little ways from the route but still visible.
	A Pond	A small pond to the side of the route.
	An Outdoor Theatre	A small outdoor theatre. Situated across the river from the route. Glasgow University tower is visible beyond it.
	Hillhead Primary School	A large modern school building, situated across the river from the route.
	The Robertson Memorial	A large equestrian statue, situated on a hilltop position but visible from the route.
	St Silas Church	A small Victorian church, situated at the end of the test-route. Its gable end is visible.
Edge	The River Kelvin	A medium-sized river, following most of the test-route and often visible.
Districts	Finnieston	A district the walker moves away from.
	City Centre	A district the walker parallels.
	Park Circus	A district the walker parallels.
	Hillhead	A district the walker moves towards.

Table 5.7 The environmental element master list developed for the test site; wherein landmarks, districts and an edge are identified.

Having identified these elements, the prototype's technical architecture was then considered. Due to the researcher's skills set, it was decided that the dynamic and interactive aspects would be enabled through a combination of HTML 5, CSS and JavaScript. Here, it was envisaged that the prototype would be presented on a single webpage containing a single button. By pressing this button, the site would query the device's coordinates and compare this data to a pre-defined array of possible coordinates. If a positive match was made, then a location-specific image, i.e. the WI, would be downloaded and appear on screen. As with the FS designs, it was also intended that this image would be programmed to *rotate* in accordance with the data drawn from the device's sensors. In this way, the representation would hold alignment with the direction of environmental features. (A brief description of the prototype's technical architecture and its underpinning code is provided in Appendix G; the final .html file is available on the Memory Key on the inside cover of this thesis).

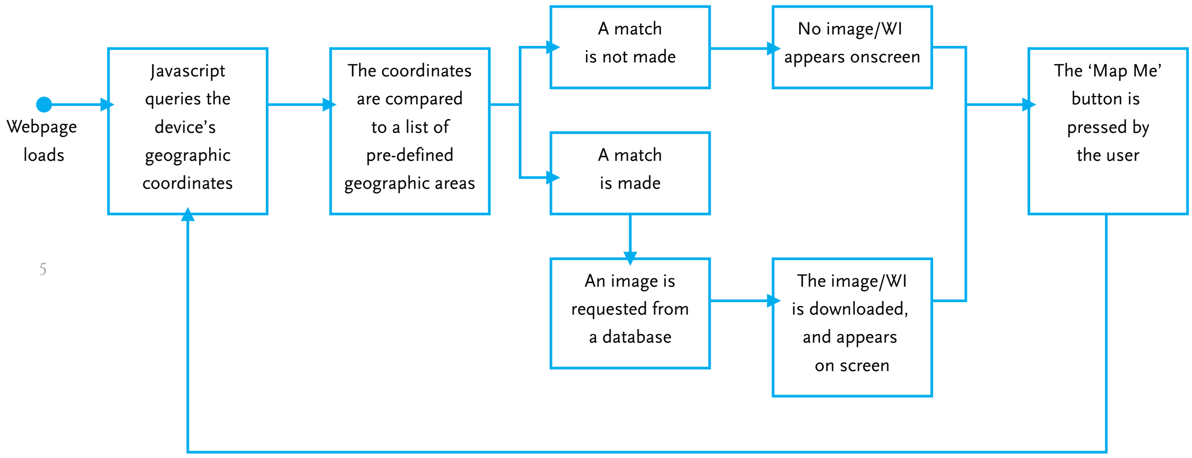


Fig. 5.33 A model of the prototype's system as it was envisaged at the onset of the design process.

Taking this approach, then, it was necessary to develop a set of unique images/WIs to appear at particular locations along the route. In order to define these locations, the decision was taken to divide the route into a number of sections, which might then be linked to the specific representation (i.e. a unique representation would be produced for each section). This resulted in the test-route being divided into a sequence of nine distinct sections extending for a minimum of 10 metres and a maximum of 80 metres. These sections were defined as distinct on the basis that each was seen to offer an enclosed 'vista', i.e. a unique, contained line of sight (Gibson 1986/1979:198, see Section 2.3.2). In the below figure the proximate boundaries of these sections are marked out with black lines intersecting the pink test-route line.

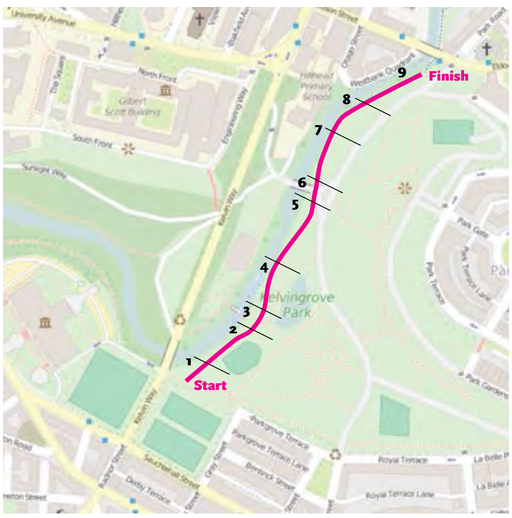


Fig. 5.34 The test-route divided into nine sections. Sectioning the route in this way allowed the researcher to determine the relations between the key environmental elements of the route and the specific location. Having collected this data, it was then possible to develop a unique representation to be downloaded and appear on screen at each location, based on a single button press.

From this, the next step taken was to define the relations between each section and the landmarks, the edge and the districts. Here, data collection was undertaken with a digital compass onsite. The degrees at which each relevant landmark, edge or district was positioned were logged in a sketchbook. On the right hand side of figure 5.35 below, we see an example of the logging process.

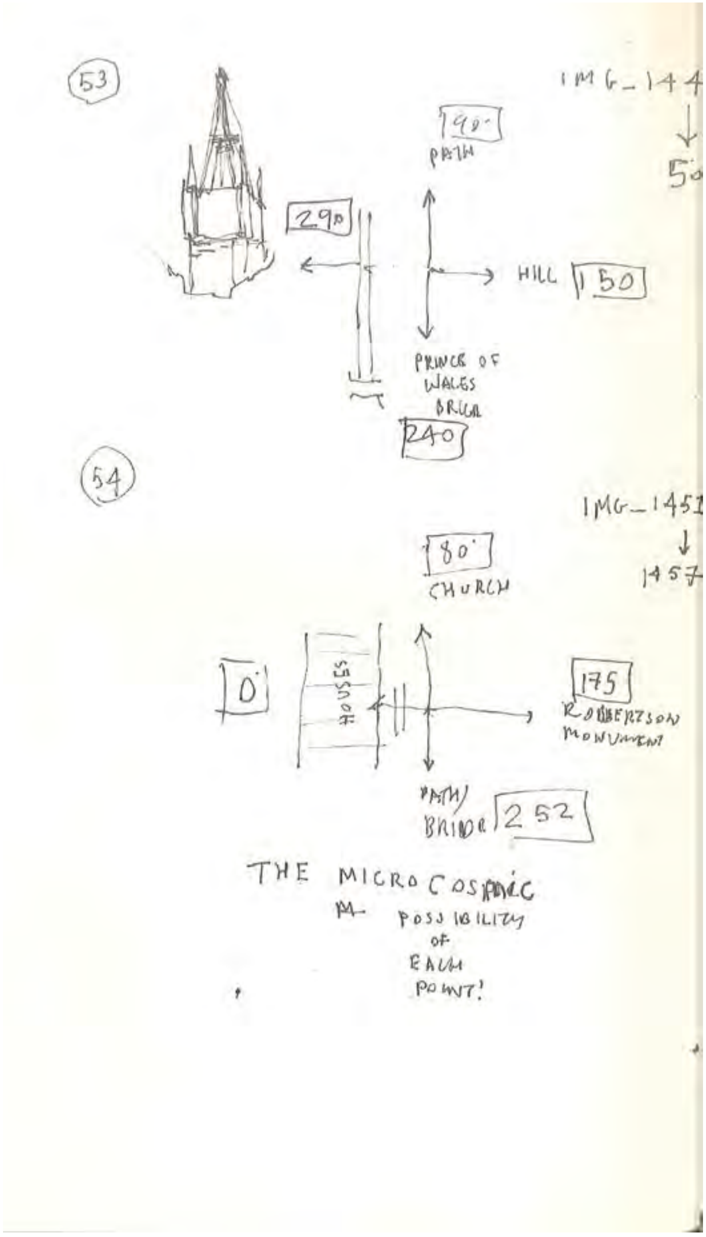


Fig. 5.35 A drawing of a section of the test-route where Glasgow University can be seen. On the right hand page, the direction of particular features (in degrees) are recorded for two given sections.

Having collected this data, the next step was to design the set of nine images/WIs, i.e. one per section. In doing so, the visual approach that had been established in the FS designs was further adapted. The below table provides an overview of the specific decisions made in relation to particular features of the interface. Additionally, Appendix C offers a detailed outline of the researcher's immediate thinking within the design process.

Decisions Taken in the Design of the Prototype

Interface Design Feature(s)	Approach Taken	Decision Made in Relation to the Last FS Design (i.e. FS#7 from the field simulation test, see fig. 5.26)
Graphic Space	No true distances are represented. The graphic space is divided into 'here', 'near' and 'far'.	There was no 'near' space in FS#7. It was posited that the addition of a dedicated space for 'near' features would render apparent the distinction between near and far in the representation.
You are Here Representation	A large circular representation appears in the centre of the screen.	The representation is slightly smaller to allow for more space on screen for the representation of 'near' features (see above).
Landmarks	Semi-realistic literal representations (i.e. flat 2-D literal representations) and triangles are applied for visible landmarks. Words and triangles are applied for non-visible landmarks (i.e. landmarks that the walker can't see).	A similar approach had been taken in FS#7, as this had appeared to be successful, particularly for participant EP#14 (see Section 5.3.4), the researcher decided to reapply it.
Districts	Districts are represented by wedge-shapes containing text and a triangle. These appear at the outer edge of the interface (i.e. they are denoted as being 'far').	Wedge-shapes were used to denote districts in FS#7, as well as in previous FS designs (i.e. FS#5, and FS#6). There had been no objections to this approach, and so it was reapplied.
Edge	The edge graphic object, i.e. the river, is represented by a rectangular block, indicating its linear character. This appears near the centre of the interface (i.e. it is denoted as being near).	Lines were used to denote edges such as rivers and motorways in FS#1, FS#3, FS#4, and FS#7. There had been no objections to this approach, and so it was reapplied.
Declarations of Time	The time to districts was contained in the district shapes.	This approach had been applied in four FS designs (i.e. FS#4, FS#5, FS#6 and FS#7). Participant EP#9 had stated that this was useful and, as such, it was reapplied.

Table 5.8 An overview of the decisions taken in relation to particular features in the design of the final prototype. Additionally, in the right column, we see a consideration of how the design developed from the last FS design (i.e. FS#7).

The final design appeared on a single webpage, with a single button reading 'Map Me'. On pressing the button, a unique, location-specific, rotating representation appeared on screen. Below, a series of photographs are presented, demonstrating the prototype in-situ. Further, by turning to Appendix K a link to a video, demonstrating the prototype in use, may be accessed. (This same video may be found on the Memory Key, attached at the inside front cover of the thesis).

Fig. 5.36 The prototype shown in use at the start of the test-route. Here, the first unique representation is shown facing Glasgow University tower (i.e. the silhouette in the distance). Relating to this, we see that the triangular shape at the top of the screen denotes the direction at which the tower can be seen by the user.

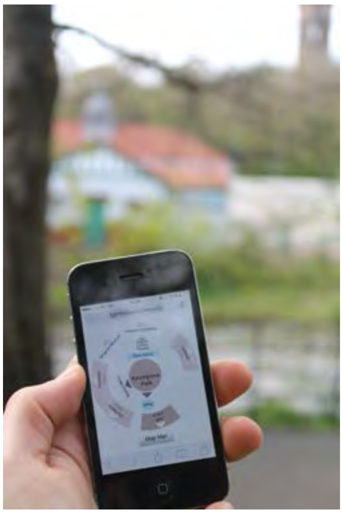


Fig. 5.37 The prototype shown in use at the middle of the test-route. Here, the third unique representation is shown facing the outdoor theatre (i.e. the red-roofed building in the middle distance). Relating to this, we see a shape toward the top of the screen, above the large circle, denoting the direction at which the theatre can be seen by the user.

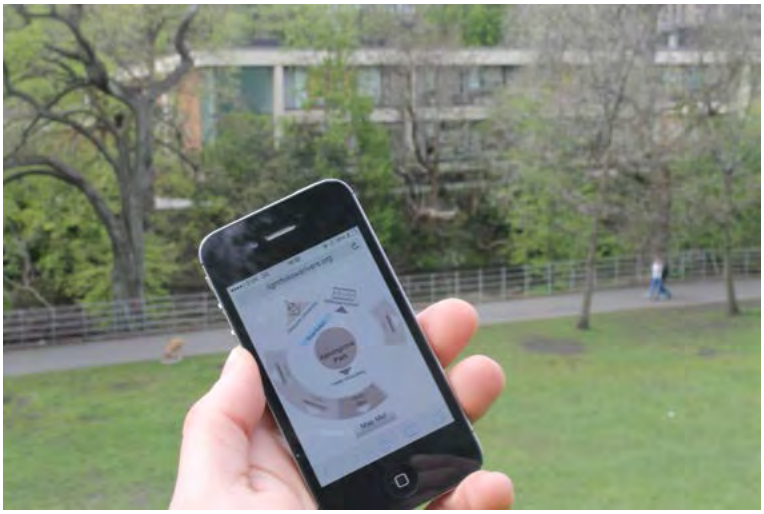


Fig. 5.38 The prototype shown in use near the end of the test-route. Here, the seventh unique representation is shown facing Hillhead school (i.e. the modern building in the middle distance). Relating to this, we see a shape toward the top of the screen, above the large circle, denoting the direction at which the school can be seen by the user.

Fig. 5.39 The prototype shown in use at the end of the test-route. Here, the ninth unique representation is shown facing St Silas Church (i.e. the sandstone gabled building in the middle distance). Relating to this, we see a shape toward the top of the screen, above the large circle, denoting the direction at which the church can be seen by the user.

With the design of the prototype complete, it was then necessary to assemble a participant group.

5.4.2 The Prototype Test Participants' Reported Walking Practices and Levels of Familiarity with the Test-route

In total twenty-one participants were recruited in the prototype test. As with the field simulation test, recruitment was first based on purposive sampling and, thereafter, on snowball sampling (see Section 3.3.3). In what follows, it should be noted that EP#16's results have been excluded from the final dataset as this case was treated as a pilot for the whole. (For an overview of EP#16's participation, turn to Section C.8 in Appendix C, wherein a brief reflection is offered).

With regard to the remainder of the group's walking practices, most participants were regular walkers. Beyond this, there were four participants who only occasionally walk recreationally. These participants claimed to walk either while traveling, or in one case inconsistently in local contexts. (These cases will be dealt with in greater detail in Chapter 6; see Section 6.1). Finally, it was discovered that one participant did not walk recreationally. His inclusion within the test was due to the recommendation of a previous participant, who felt that he would provide an appropriate case. Though he did not engage in urban recreational walking/wandering, he was still able to interpret and 'use' the interface (see Section 5.4.3). Accordingly, his data has been retained.

Beyond this, the group held variable levels of familiarity with the test-route. While initially the researcher sought only participants who were unfamiliar with this site, snowball sampling meant that it was often not possible to determine the level of familiarity held by recruits prior to testing. Thus, in testing, it emerged that though most of the group were not at all familiar with the route, some held a degree of familiarity, and others were quite familiar.

Thus, in summary, we may say that the majority of participants were regular recreational walkers/wanderers and that levels of familiarity with the test-route were variable across the group. The impacts of these various factors in the test will be dealt with in the next chapter (see Sections 6.1.1 and 6.1.2.1).

For, now we will move on to consider the parameters of the test itself.

5.4.3 *The Test*

Fig. 5.40 A prototype test participant at the start of the test-route. Under the rim of the baseball cap, it will be noted that a miniature camera is visible (i.e. the black object). This camera recorded participants' I-E interactions as they walked the test-route unaccompanied.

The prototype test was divided into two parts. First, participants were issued with an orientation task, wherein Google Maps was used. In this orientation task, participants were asked to tell the researcher what was 'around', based on the information presented on screen. Then, in the second part, the participants were asked to 'use' the prototype as they walked along the test-route. Use was here presented as pressing the 'Map Me' button (see Section 5.4.1 above) at two different points on the route. It was thereby intended that participants would see at least two separate representations (i.e. images/WIS) and, as such, experience these representations in-situ.

In data collection and analysis, focus was directed towards the qualitative aspects of participants' experience in relation to the prototype. Thus, a semi-structured interview was conducted with all participants at the end of their walk. In addition to this, through observation, attention was also paid to their I-E interactions in use. That is, to where they looked and for how long. Here, the results obtained for Google Maps were compared to those for the prototype. The former sets of results (i.e. those obtained for Google Maps) were positioned as a contrasting baseline profile against which the latter results (i.e. those obtained for the prototype) might be contextualised. In order to facilitate this process, the whole test was videoed. (See Section 3.3.8 for a detailed outline of the method.)

From here, we first consider the interview questions and the analysis of this data.

5.4.4 *Formulating the Semi-Structured Interview Questions and the Results of the Analysis of the Interview Data*

In focusing on the qualitative aspects of participants' experience in relation to the prototype, the semi-structured interviews sought two categories of data. Firstly, data against which the success of the prototype might be assessed; and, secondly, data which might eventually allow for the generation of a contextualised graphic syntax *for* design (Engelhardt 2002; Zimmerman et al. 2010; see Section 3.3.9). Thus, it was necessary to devise an interview guide (Bryman 2008:471), which would, on the one hand, *enable* assessment and, on the other, *allow* for the generation of a contextualised graphic syntax.

In regard to assessment, the development of this interview guide was informed by the goals underpinning the design hypothesis (see Section 4.3), namely:

- to ensure that exploratory wayfinding practices were still possible;
- to support an urban recreational walker's/wanderer's SA-in-use.

From these goals, two initial lines of questioning were established. The first related to participants' *experiences with* the prototype (i.e. what *happened* in use). The second related to their *experience of* the prototype and Google Maps (i.e. what was each *like* to use).

It was intended that data collected in response to the first line of questioning, would be assessed for the components of exploratory wayfinding identified in the enquiry's first phase (allowing the researcher to judge whether or not exploratory wayfinding practices might still be possible in use; see Section 4.2.2).

Next, it was intended that data collected in response to the second line of questioning would be integrated with the *quantitative* data collected through observation (allowing for an assessment of whether or not SA-in-use had been supported against the statement regarding this, set out in the conceptual framework; see Sections 2.4 and 6.1).

Beyond the above, in regard to generating a contextualised graphic syntax, two further lines of questioning were established. These related to participants' information design experience (i.e. how they interpreted the structure of the arrangement of graphic content in graphic space) and the meaning they ascribed to the interface (i.e. what they thought it was for).

Having identified these lines of questioning, the following participant-centred questions were formulated:

- What happened when you used the app?
- What is the app like compared to Google Maps?
- How do you feel about the visuals?
- Can you imagine a use for the app?

As with the analysis of the programme of semi-structured interviews in the first phase (see Chapter 4), interpretative phenomenological analysis (IPA) was applied in the analysis of the data collected in response to these questions (see Section 3.2.5).

In considering the results of analysis in the following sub-sections, we will first set out the broader organising themes where applicable. Thereafter, the more frequent basic themes will be dealt with, such that the core of the material may be accessed. In addition, brief conclusions will be offered at the end of each section, which are then subsequently consolidated by broader conclusions, set out in the next chapter (see Section 6.1).

We begin by turning to the analysis of responses to the first question, wherein participants' *experiences with* the prototype (i.e. what happened) were considered and assessed.

5.4.4.1 Assessing Participants' *Experiences with* the Prototype Interface for Components of Exploratory Wayfinding

In analysis of participants' *experiences with* the prototype (i.e. their description of what happened in use), the researcher began by dividing the data into what were seen to be self-contained extracts. Herein, explicit statements relating to what happened in use were sought. Alongside this, allusions to possible forms of experience were also identified. Having identified such extracts, all were coded with a brief note outlining the focus of each.

From this, in order to initiate the assessment process, it was necessary to define an *assessment sheet*. Here, the researcher returned to the results of the programme of semi-structured interviews; specifically, to the most frequent results obtained in relation to participants' descriptions of exploratory wayfinding, i.e. to what were termed the 'components' of exploratory wayfinding (see Section 4.2.2). These components were identified as either *tactical* or *experiential* (see Section 4.2.2) and arranged on an assessment sheet, as shown in the below table.

The Assessment Sheet for Considering Participants' Experiences with the Prototype

Organising Theme	Component	Definition
Tactical Components	Exploration	The walker/wanderer seeks intriguing, unanticipated environmental features or experiences.
	Taking Emergent Paths	The walker/wanderer has no fixed path in mind, and allows the affordances of the environment to shape their route.
	Directional Movement	The walker/wanderer knows the general direction in which they are heading, but not the specifics of the route.
	Linking to the Familiar	In their walking, the walker/wanderer links unfamiliar environments to familiar environments.
	Compelled by the Immediate	The walker/wanderer makes routing decisions based on encountering particular environmental features or qualities.
Experiential Components	Noticing	The walker/wanderer becomes mindful of features within the immediate environment.

Table 5.9 The final assessment sheet containing definitions of the six most popular components of exploratory wayfinding that emerged in analysis of the interviews data in the enquiry's first phase (see Section 4.2.2).

From the above, the researcher began a process of matching the coded extracts to particular *tactical* or *experiential* components of exploratory wayfinding. The full list of matched extracts is presented below next to the relevant, respective component.

Matches Made between Test Sheet Components and Participants' Outlines of their Experience with the Prototype

Organising Theme	Component of Exploratory Wayfinding Experienced	EP No. (in order of assigned number)	The Associated Extract
Experiential Components	Noticing	EP#17	'I learnt that the thing was called the… I forgotten now but I learnt the name of the memorial in the middle of Kelvingrove which I'd never known.'
		EP#18	'it named the simple things around me.'
		EP#19	'It's a very intuitive interface. Where it kind of knows where you are and what's around you. What's actually worth looking at close to you.'
		EP#20	'So it just made you look at them. Basically as I was going on the walk and I guess self-consciously because of this as well I thought okay, I'm going to pay attention to this then.'
		EP#22	'You look this way and that's where the thing is.'
		EP#23	'It was interesting with the school, you know, you see something and you're like, oh right what's that, and then that comes up.'
		EP#24	'And, yeah, no, it made me more aware of what was worth looking at.'
		EP#25	'…it kept showing me [Lifts finger and points.] what is here.'
		EP#27	'Hillhead school popped up when I pressed Map Me just before the bridge that crosses the Kelvin and Hillhead itself comes into play, roughly halfway along I think…'
		EP#31	'[It] put[s] yourself in perspective to other things around you rather than like a flat kind-of, yeah.'
		EP#32	'And also I didn't notice the memorial that wasn't there just after that I just noticed that and I took a look.'
		EP#33	'I liked it because it really accurately pointed out the landmarks and direction.' [Indicates near features.]
		EP#35	'I wasn't expecting the school for instance so when I looked at the Hillhead school that's not something I would normally look up, but it was nice to know that its here.'
		EP#36	'I like the fact you picked out things in the park because, okay, we're just looking in the park but I didn't notice the Stewart Memorial.'

Organising Theme	Component of Exploratory Wayfinding Experienced	EP No. (in order of assigned number)	The Associated Extract
Tactical Components	Directional Movement	EP#19	'…it like centres you. You don't really know how to get to where you want to go but you know you're going in the right direction which is fine.'
		EP#21	'I think it's interesting because its kind of a general direction. Rather than like go this way or that way.'
		EP#28	'I kind of like that it is pointing out that the city centre is over there or Glasgow University's over there because a lot of the time… when you look at maps you kind of, you don't, you don't always want to wander in a strict direction you kind of want some reassurance you're going in the right direction, so I think it would be helpful for that.'
	Exploration	EP#17	'…this its much more of a wander I think. It didn't give you any specific directions.'
		EP#28	'So like when it popped up over the pond there and I'd not thought, I know there's definitely a pond around here somewhere, oh it kind of made me think, I'll have a look at that pond, oh where is this pond in relation to where I am now?'
		EP#29	'And it made me kind of look for things that I didn't know were there.'
	Taking Emergent Paths	EP#26	'Am— when I came to decision points it seemed to make a lot of sense because you could just… if well, if you wanted to go to one of those things…'

Table 5.10 The above table sets out the matches made between the test sheet components and participants' experiences with the prototype.

The most striking of observation made from the above table is the prevalence of extracts, which match with the *experiential* component of *noticing*. While still present, *tactical* components such as *directional movement*, *exploration* and *emergent paths*, were less frequently matched.

In those extracts that were matched with *noticing*, participants tended to speak of how, in using the prototype, they became aware of particular features in the environment. For some, this was simply a matter of finding the name ascribed to a feature within their view. For others, the act of noticing was attributed to the interface. As one participant, EP#22, put it: 'You look this way and that's where the thing is.' Somewhat surprisingly, some appeared to value to the guidance of the interface. For example, EP#24 claimed that it made him more aware of 'what was worth looking at'. Though this is concerning, the view is taken that allowing users to select particular types of content might reduce the potential for such distortions in individuals' perception of value, i.e. their perception of what is 'worth looking at' (see Section 7.7.3, wherein directions for future research are discussed).

Turning then to those extracts which were matched to the *tactical* components of *directional movement*, *exploration* and *taking emergent paths*, we see that participants offer brief fragments which allude to the relevant, respective component. For example, with regard to *directional movement*, EP#19 simply speaks of knowing that he's 'going in the right direction'. With regard to *taking emergent paths*, EP#26 noted how, at 'decision points' the interface made 'a lot of sense [...] if you want to go to one of those things.' Though these extracts are short, it is held that each component is nonetheless represented.

Beyond the above, it must be pointed out that two participants, EP#30 and EP#34, did not relate any direct experience or indeed allude to a potential experience, which could be matched with a component on the assessment sheet. (This disparity will be dealt with further in Chapter 6; see Section 6.1.2.1).

Taking these latter cases into account, we may say that all but two participants within the group were seen to have had experiences that could be reasonably matched to either an *experiential* or *tactical* component of exploratory wayfinding as defined in Section 4.2.2. Therefore, it would appear that exploratory wayfinding practices are still possible in use.

5.4.4.2 *Emergent Themes in Participants' Comparison of Google Maps and the Prototype*

In analysing participants' *experience of* both the prototype and Google maps (i.e. their description of what each was *like*), the researcher first divided participants' descriptions into a series of discrete extracts referring to one interface or the other. Initial codes were then applied and, from this, a set of general themes were refined and consolidated. Herein, one set of themes emerged for the prototype and another for Google Maps.

Aggregating these sets of basic themes, two organising themes were identified. Here, participants were either seen to take an *environmental focus* or an *interface focus*. In taking an *environmental focus* participants spoke of how the interface *directly related* to their surroundings or the wider context. Conversely, in taking an *interface focus* participants spoke of the interface almost exclusively in terms of its visual or interactive aspects. Below, table 5.11 presents a definition for each of these organising themes and then lists the associated basic themes depending on whether they relate to the prototype or Google Maps.

The Organising Themes Relating to Participants' Experience of Each Interface

Organising Theme	Definition	Basic Themes Associated with the Prototype	Basic Themes Associated with Google Maps
Environmental Focus	Participants refer to the interface in terms, which relate to the surroundings or the wider context.	Immediate relationality. General relationality.	Challenging in orientation.
Interface Focus	Participants refer to the interface almost exclusively in terms of its visual or interactive aspects.	Ambiguous directionality. Compelling novelty. Direction-based relationality. Egocentric relationality. Non-route based.	Graphically dense. Information rich. Few features represented. Metric representation. Non-egocentric. Non-trustworthy. Offers a wider context. Rich interactivity. Route-based.

Table 5.11 The basic themes relating to participants' experience of each interface divided between two organising themes, according to whether they relate to the prototype or Google Maps. Here, the basic themes are seen to suggest either an environmental focus, or an interface focus.

From the above, the full set of basic themes are defined and presented, alongside their respective organising themes, on two separate tables below (i.e. one for the prototype and one for Google Maps).

Emergent Themes Relating to Participants' Experience of the Prototype

Organising Themes	Themes Associated with the Prototype	Definition	EP No. (in order of assigned number)	Example Statement
Environment Focus	Immediate Relationality	Participants refer to the interface in terms of how the representation allows them to relate to immediate features.	EP#20, EP#21, EP#22, EP#23, EP#24, EP#25, EP#29, EP#35, EP#36	'And yeah I think having more points to verify it by and encouraging me not to just look at the map its kind of like ooo— look at this or I felt like I was looking around more than if I was just using the map.' —EP#29
	General Relationality	Participants refer to the interface in terms of how the representation allows them to relate to other features.	EP#17, EP#31	'I guess there's no streets, no kind of like navigation along a path, or a route, so you're kind of following it in perspective to other, your relation to other things.' —EP#31
Interface Focus	Egocentric Relationality	Participants refer to the interface in terms of how the representation, privileges their position, possibly in relation to other features.	EP#18, EP#19, EP#29, EP#36	'...the app is relevant to where I am.' —EP#36
	Direction-Based Relationality	Participants refer to the interface in terms of how its directional representation allows them to relate to other features.	EP#27, EP#28, EP#32	'[...] with this its just, it strips everything back so you're not concentrating so much on following a strict route you're just floating more or less. So you know you're going in the right place but you're not kind of strictly following any instructions. I guess simplicity and less structure...' —EP#28
	Compelling Novelty	Participants refer to the interface in terms of how its representation is innovative and interesting.	EP#30	'I think its something a bit different [...] something like this would make you look at your map a bit more... you know what I mean because its actually quite fun to use.' —EP#30
	Non-Route Based	Participants refer to the interface in terms of how the representation does not allow for precise navigation.	EP#33	'This one doesn't have [routes] so maybe if you had that and then in correlation to that it would be nice yeah.' —EP#33
	Ambiguous Directionality	Participants refer to the interface in terms of how its directional representation is general and not specific.	EP#34	'... here you follow it but you don't really know how [Indicates winding path.], like you can imagine how and maybe looking also around you can understand...' —EP#34

Table 5.12 The basic themes relating to participants' experience of the prototype organised between those themes which suggest an environment focus and those which suggest an interface focus. We see that each theme is defined and linked to particular participants, and accompanied by an example statement.

Emergent Themes in Relation to Participants' Experience of Google Maps

Organising Themes	Themes Associated with Google Maps	Definition	EP No. (in order of assigned number)	Example Statement
Environment Focus	Challenging in Orientation	Participants refer to the interface in terms of how the representation can inhibit spatial orientation.	EP#22, EP#23, EP#27	'...on Google Maps, even if you triangulate it or whatever and its still off, its not, this is where you need to go!'
Interface Focus	Route-Based	Participants refer to the interface in terms of how its representation supports precise navigation.	EP#17, EP#21, EP#31, EP#33, EP#34	'Google Maps shows you point A to point B right, I quite like that part of Google Maps but not necessarily the street view.' —EP#33
	Graphically Dense	Participants refer to the interface in terms of how the representation contains an excessive level of content.	EP#22, EP#25, EP#32	'Google maps it's a bit messy. Because maps are messy. And towns are messy.' —EP#32
	Offers a Wider Context	Participants refer to the interface in terms of how its representation offers a broad spatial overview.	EP#20, EP#34	'...well its clearly not about the wider location or Glasgow like Google Maps I think.' —EP#20
	Non-Egocentric	Participants refer to the interface in terms of how its representation negates the user.	EP#18, EP#36	'Google maps is just out there.' —EP#36
	Rich Interactivity	Participants refer to the interface in terms of the extensive interactive options it affords.	EP#30	'Google Maps you can play around or change things up a bit...' —EP#30
	Few Features Represented	Participants refer to the interface in terms of how its representation of features is minimal.	EP#24	'... a map [...] shows the odd feature, here or there.' —EP#24
	Information Rich	Participants refer to the interface in terms of how its representation is rich in content.	EP#28	'Google Maps [there] is a lot of information there, its thorough, it includes everything.' —EP#28
	Non-Trustworthy	Participants refer to the interface in terms of how it does not imbue trust.	EP#29	'Google, I don't really trust that much. Even though it's a big corporation.' —EP#29
	Metric Representation	Participants refer to the interface in terms of how its representation offers accurate distance measures.	EP#26	'I guess, understanding your distance from something because I'm more spatial seeing a map.' —EP#26

Table 5.13 The basic themes relating to participants' experience of Google Maps organised between those themes which suggest an environmental focus and those which suggest an interface focus. We see that each theme is defined and linked to particular participants, and accompanied by an example statement.

As may be observed from tables 5.12 and 5.13, the prototype is often spoken of in terms relating to the themes of: *immediate-relationality*, *direction-based relationality*, and *egocentric relationality*. Google Maps, on the other hand was mostly seen as: *route-based*, *challenging in orientation*, and *graphically dense*. It will be helpful to consider each of these themes in turn and, where appropriate, highlight some underlying distinctions.

With the prototype, the theme of *immediate-relationality*, which suggests an *environmental focus*, emerges most prominently. Here, participants referred to the interface in terms of how the representation allowed them to relate to immediate features in the environment. Some spoke of being alerted to such features. Others claimed that the interface allowed them to attend to 'where you are in that moment' or else what they were 'looking at already'. Additionally, aligned with these, EP#24 spoke of how, with the interface, he 'looked [around] that bit more, to get it fully in'.

With the next theme, *direction-based relationality*—which was seen to suggest an *interface focus*—participants referred to the interface in terms of how its directional approach to representation allowed them to relate to other features. Some noted how the levels of content were reduced and general directions were provided in place of dense information. EP#32 likened using the interface to receiving directions from someone.

With the last prominent theme—*egocentric relationality*—participants referred to the interface in terms of how the representation privileged their position in relation to other features, again suggesting an *interface focus*. Some spoke of how their position was centred. For EP#36 it was about 'where I am'. EP#18 appeared to suggest that the representation integrated well within her immediate experience of the environment: 'It's not like you and the map, it's exactly just like you.'

Moving onto to participants' experience of Google Maps, we see that the theme of *route-based*—suggesting an *interface focus*—emerges most prominently. Here, participants spoke of the interface in terms of how its representation supported precise, exact forms of wayfinding. Often, emphasis was placed on navigational functionality: EP#21 mentioned 'route' planning; EP#17 spoke of 'following lines'; EP#31 spoke of 'following a path' and going 'left and right'; EP#33 and EP#34 both mentioned 'A-to-B' routing.

With the next prominent theme to emerge in relation to Google Maps, *challenging in orientation*, we see that participants referred to the interface in terms of how its representation can inhibit spatial orientation, suggesting an *environment focus*. Here, participants' extracts were all framed in negative terms. For EP#22 there was no clear orientational aspect to the representation. EP#23 claimed that she found it difficult to draw a conceptual link between the environment and the interface. EP#27 noted how, in seeking a direction, zooming between various scales, as well as having to 'follow yourself looking at the blue dot' impacted upon the interface's usability.

Finally, with the last prominent Google Maps theme—*graphically dense*—participants referred to the interface in terms of how its representation could contain excessive levels of content, which is seen to suggest an *interface focus*. EP#22 said there was 'too much information'. EP#25 said it was 'crowded'. EP#32 described Google Maps as 'a bit messy'.

Collecting the above, we see that with the prototype, the themes of *immediate relationality* and *general relationality* have emerged from the contributions of a larger portion of the group. Therefore, we may conclude that, in their experience of the prototype, a slight majority of participants appear to have taken an *environmental focus*. Conversely, with Google Maps, we see that the themes with an interface focus predominate (i.e. *route-based* and *graphically dense*). Therefore, we may conclude that, in their experience of Google Maps, a large majority appear to have taken an *interface focus*.

All of these themes will be considered further in Chapter 6 when they are integrated with the quantitative results of observation (see Section 6.1.2). Here, the researcher will assess whether or not SA-in-use had been supported against the statement set out in relation to this in the conceptual framework (see Section 2.4).

5.4.4.3 *Emergent Themes in Relation to Participants' Information Design Experience*

In analysing participants' information design experience (i.e. how they interpreted the arrangement of graphic content in graphic space) the researcher first divided participants' descriptions into a series of discrete extracts relating to elements of the interface. As analysis proceeded, it was recognised that, in these references, participants were discussing the interface on three separate levels: in terms of the whole interface, in terms of a particular feature and in terms of the properties of particular features. Furthermore, these references were found to be both positive and negative.

Thus, the themes which emerged in relation to participants' information design experience will be discussed in relation to the three separate levels identified and, therein, divided according to whether or not the theme was positively or negatively framed. We begin, then, with the below table setting out participants' information design experience at the level of the *whole* interface.

Participants' Information Design Experience at the Level of the Whole interface

The Value Ascribed	Theme	EP No. (in order of assigned number)	Associated Utterance
Positive Attributes of the Whole Interface	Direction-Based	EP#20, EP#21, EP#23, EP#24, EP#25, EP#27, EP#31, EP#34, EP#35	'And it showed you very easily what direction, when you were changing, where you were going. No it was very, very good.' —EP#24
	Clear/Simple	EP#17, EP#27, EP#29, EP#32, EP#34	'It was very clear and simple...' —EP#17
	Rotation	EP#17, EP#18, EP#23	'Am— I enjoyed the rotation, the width span which was nice.' —EP#17
	Near and Far Differentiated/ Represented	EP#20, EP#32	'And after starting to use [it], I just realise[d] that the nearest a— am arrows am— gives, indicates from things that are closer and here things that are far away.' —EP#32
	'360 View'	EP#27	'Aye, so it was quite straightforward. I guess you're, you see yourself as the centre of... that image that's there and it just gives you a kind of 360 degree view of the main features of what's around you I guess.' —EP#27
	Neutral Colours	EP#18	'And the colouring was nice because its just nice and neutral.' —EP#18
Negative Attributes of the Whole Interface	Under-Resolved	EP#17, EP#22, EP#28	'I think it worked fine. There's definitely an opportunity, to make it a bit more, I don't know... develop the graphics.' —EP#28
	Readability of the Text	EP#17, EP#23, EP#36	'The only thing I struggled with was I wanted to read the writing which was upside down so I turned the phone and of course then it turned.' —EP#17
	Proximity of Features	EP#23	'But that was when two objects appeared on the screen and one was at eleven o'clock and one was at two o'clock. So reading one and then adjusting it to see the other.' —EP#23
	Intensity of Rotation	EP#29	'It is very reactive to my steps, kind of—' —EP#29

Table 5.14 An overview of participants' information design experience in relation to the whole interface. The themes are divided according to whether they were positively or negatively framed. Additionally, on the right we see example statements for each.

From this table, we see that, in discussing the whole interface in positive terms, participants have focused on the themes of: the interface being *direction-based*; and (what is seen as) its *clear/simple* design.

With the *direction-based* theme, reference was made to how the interface's design provided an orientation. Participants either spoke of direction directly, or of being shown what was 'around', or how things were presented 'in relation to each other'. Beyond these, some made indirect comments suggesting that they too have interpreted the design in orientational terms. EP#20 drew a direct comparison between the interface and environmental signage. 'It was like carrying one of these' he said, pointing to a nearby signpost, 'except interactive sort of'. EP#23 ventured that it 'feels' like a compass. Lastly, EP#35 provided an extended description of whole interface, wherein she spoke of being 'oriented'.

Within the *clear/simple* theme, participants spoke of how they felt the design was minimal and/or accessable. Here, some were seen to make short and direct comments alluding to accessibility of the interface. EP#28 stated that it 'clears out some of the clutter'. While EP#29 discussed clarity in terms of detail: 'I wouldn't add much more detail in terms of colour contrasts, because that, you know, its am— its clear'.

Beyond the above, we see that a significant number of participants discuss two aspects of the whole interface in *negative* terms. Here, the themes of the design being *under-resolved* and the *readability of the text* emerge.

With regard to the theme of the design being *under-resolved*, the interface was seen as unsatisfactory in terms of the level of refinement it presented. For EP#17 it was ' a bit wireframe' and, for EP#22, 'basic'. Additionally, EP#27 noted that there was an opportunity to 'develop the graphics'. These contributions are seen to contrast directly with those who described the design as *clear/simple* in positive terms. Interestingly, EP#17 said the design was 'very clear and simple' *after* having expressed his dislike of the 'wireframe' structure. In doing so, he acknowledged the contradiction.

From the point of view of the research, in seeking to visually support SA-in-use a trade-off has been made wherein clarity is prised over detail. This is seen as a necessary compromise on the basis that focus has thus been directed towards the interface's essential structure rather its aesthetic qualities. Thus, while the latter may require more attention, it is held that the former is well conceived. As such, no further action has been taken to address this criticism, though it has been identified as an area for future research (see Section 7.8.2).

Regarding the theme of the *readability of the text*, participants either struggled to read the text as the interface rotated or else found the text size too small. The first issue might be addressed by ensuring that the text rotated *with* the interface (i.e. always remained level). Then, beyond this, the emergence of the second issue may indicate that more consideration needs to be given to the text size. In any case, no definite claims are made in regard to typography. Thus, as above, both issues are identified as areas for future research (see Section 7.8.2).

From this, we now turn to look at participants' information design experience in relation to the features of the interface, presented in table 5.15 below.

Participants' Information Design Experience at the Level of General and Particular Features

The Value Ascribed	Theme	EP No. (in order of assigned number)	Associated Utterance
Positive Attributes of General and Particular Featuress	Symbols	EP#17, EP#18, EP#20, EP#29, EP#30, EP#32, EP#36	'I like that it picked up specific memorials in different areas and stuff am…' —EP#29
	Inclusion of Monuments	EP#17, EP#21, EP#29, EP#35, EP#36	'…what I did like, I mean, its come up here with the Robertson Memorial, which I didn't know existed, so I think that's pretty good.' —EP#21
	Inclusion of the River	EP#18, EP#23	'I could see that I'm right beside the river constantly which is great. I knew it was working.' —EP#18
	Declarations of Time	EP#17, EP#36	'I like the fact it told you time rather than distance.' —EP#17
	Inclusion of the School	EP#23, EP#35	'And like when passing Hillhead primary school it popped up and the little graphic was very similar to the structure of the school, it was kind of, so again that would give you reassurance that you're in the right place.' —EP#23
	Representation of Districts	EP#35	'With the streets on the periphery and the fact that in the park, so that was constant and that helped me kind of you know, stay oriented.' —EP#35
Negative Attributes of General and Particular Features	Basic Representation	EP#27, EP#28	'Well… the visuals are pretty basic in terms of the symbols.' —EP#27
	Representation of Districts	EP#22	'Like the blocks. I'd like it to have more, something specific to Kelvingrove park or something specific to what it actually is rather than a little block.' —EP#22

Table 5.15 An overview of participants' information design experience in relation to general and particular interface features. The themes are divided according to whether they were positively or negatively framed. Additionally, on the right we see example statements for each.

Reviewing the themes that emerged in relation to participants' positive references to features, we find that the *symbols* and the *inclusion of monuments* appear prominently.

With the theme of the *symbols*, most participants simply stated that they *liked* the representation of landmarks by offering examples. Further to these, EP#20 stated that the 'icons helped', while EP#32 describes the representation of landmarks as 'pretty simple' and, as such, 'good'.

Then, with the theme of the *inclusion of monuments*, participants again stated that they *liked* seeing these appear. It would seem that the inclusion of monuments generally enriched participants' experience of the walk. This is particularly the case for EP#36 who, despite claiming to be familiar with the route, noticed a previously unknown monument.

The themes of the *inclusion of the river* and the *inclusion of the school* suggest similar experiences. For EP#23, the inclusion of the river provided a 'grounding'. EP#28 noted how the school's appearance provided a sense of 'reassurance'.

From this, we now look to participants' experience of the properties of features.

Participants' Information Design Experience at the Level of the Properties of Features

The Value Ascribed	Theme	EP No. (in order of assigned number)	Associated Utterance
Positive Attributes of the Properties of Features	Graphic Object Connects	EP#19, EP#22, EP#24, EP#25, EP#28	'…it was quite good. There was no difficulty in relating the landmark to the points. It was quite easy.' —EP#24
	River as a Small Section	EP#17	'Depicting small sections such as the river rather than a solid line was actually quite nice. I like that.' —EP#17
	Differentiating Points from Areas	EP#17	'I like the wee memorial and the university drawings. That's nice to differentiate a specific location rather than areas like Hillhead or Garnethill…' —EP#17
	Simplicity of Pond	EP#18	'Yeah, I thought the interface was very good cause, I don't know, for simple things like the pond it was just a nice blue circle, it said pond…' —EP#18

Table 5.16 An overview of participants' information design experience in relation to the properties of interface features, on the right we see example statements for each.

Among the themes relating to the properties of interface features, the *graphic object connects* emerges most prominently. Herein, participants were seen to identify a link between the information presented on screen and that which was represented. Some perceived there to be a faithful correspondence between the graphic objects and what was seen in the environment. Further, EP#25 noted that things are *shown* and *named*: '… it kept showing me what is here. For instance, it tells me the school by name…' Lastly, EP#19, spoke of gaining 'a sense of location' by seeing that he was beside the river 'constantly'. In this description, we see that the participant links the representation of the river to the river seen in the surrounding environment and, as such, *connects* the two directly.

Having thus considered participants' information design experience of interface on three separate levels, let us now move to draw a set of conclusions from the above. To begin, in terms of the whole, many participants were appreciative of what they saw to be the *direction-based* and *clear/simple* design. In terms of particular features, many participants expressed an appreciation for the *symbols* and the *inclusion of monuments*. The inclusion of monuments in particular was seen to enrich the experience of the immediate environment. Additionally and similarly, the inclusion of the river and the inclusion of the school were seen to provide a 'grounding' and a sense of 'reassurance' respectively. Finally, with regard to the properties of individual features, some participants identified a link between the information presented on screen and that which was represented.

5.4.4.4 *Emergent Themes Relating to the Meanings Participants Ascribed to the Prototype Interface*
In analysing the meanings participants had ascribed to the interface (i.e. what they thought it was for), the researcher first divided the responses into a series of extracts wherein participants identified possible-uses.

Reviewing the basic themes, two organising themes were identified. On the one hand a number of themes were seen to suggest uses in *immersive* situations (e.g. touring), wherein the user would be keenly aware of the surrounding environment, as well as their embodied involvement within it. Conversely, the remaining themes suggested uses in *prosaic* situations, e.g. navigation. Here, it was not apparent that the user would be keenly aware of the surrounding environment or their embodied involvement in it.

In the below table, these organising themes are defined and linked to the respective basic themes with which they are associated.

The Organising Themes Relating to Meanings Participants Ascribed to the Prototype Interface

Organising Theme	Definition	Associated Basic Themes
Usage in Immersive Situations	Participants propose a use-context wherein the user is likely to be keenly aware of the surrounding environment, as well as their embodied involvement within it.	Touring. Exploration/Wandering. Orientation in relation.
Usage in Prosaic Situations	Participants propose a use-context wherein it is not apparent that the user would be keenly aware of the surrounding environment, or their embodied involvement within it.	Navigation. General wayfinding.

Table 5.17 The basic themes relating to the meanings participants ascribed to the prototype interface divided between two organising themes: those which suggest usage in immersive situations and those which suggest usage in prosaic situations.

From this, the full list of basic themes are defined below. Alongside the definitions, we find a listing of the associated participants, as well as an example statement. It should be noted that some participants suggested more than one possible-use for the prototype.

The Meanings that Participants Ascribed to the Prototype

Organising Themes	Themes (in order of frequency)	Definition of Theme	EP No. (in order of assigned number)	Example Statement
Usage in Immersive Situations	Touring	Participants express the belief that the interface might be used to undertake a tour of an environment, possibly involving sightseeing and route following.	EP#19, EP#23, EP#24, EP#28, EP#31, EP#32, EP#35, EP#36	'So I can see it in the city. It would be really nice for city walking tours.' —EP#36
	Exploration/ Wandering	Participants express the belief that the interface might be used to openly explore or wander through an environment.	EP#17, EP#20, EP#21, EP#24, EP#29	'I would wander off abjectly to look at things. It would be very difficult to plot a "via". I'll go here via there. But its not about plotting, its about wandering I think.' —EP#17
	Orientation in Relation	Participants express the belief that the interface might be used to reference particular features in the environment.	EP#18, EP#27, EP#36	'And [then] out in the countryside. So you've, it would almost be like on a bigger scale, so you're walking here, but what are you seeing around you. So what are the peaks around. What's the river down there. I did like having the Kelvin sitting there because it was your point of reference.' —EP#36
Usage in Prosaic Situations	Navigation	Participants express the belief that the interface might be used to navigate towards specific, predefined locations.	EP#19, EP#25, EP#26, EP#30	'Maybe if you've got a building you're looking for and you don't have a postcode or whatever it might be, so yeah, just any sort of wayfinding.' —EP#30
	General Wayfinding	Participants express the belief that the interface might be used in general wayfinding situations when confirmation is sought.	EP#22, EP#33, EP#34	'For example, when I use, a lot Google Maps, but every time I have to walk a bit to see if I'm going in the right direction, and then usually, I'm not going in the right direction, I'm going back like left and right. This is much easier.' —EP#34

Table 5.18 The basic themes relating to the meanings that participants ascribed to the prototype. On the left hand side we see the organising theme, then the basic theme, accompanied by a definition. In the middle we see the associated participants. Thereafter an example statement is offered for each basic theme.

From the above, it will be noted that the three most prominent themes to emerge were *touring*, *exploration/wandering* and *navigation*. Other, less prominent themes were: *general wayfinding* and *orientation in relation*.

With the theme of *touring*, participants spoke of how the prototype might be used to undertake a tour of an unfamiliar environment. Some directly mentioned concepts such as touring/tourism/sightseeing. Others spoke of individuals being in a 'new' environment and finding their way without streets. Aligning with these, EP#24 spoke of following trails. This theme was seen to suggest usage in *immersive* situations.

With the theme of *exploration/wandering*, participants spoke of how the interface might be used to explore or wander through an environment. Most mentioned exploration or wandering directly. EP#24 spoke of 'being able to look for what you couldn't see on the map'. Again, this theme was seen to suggest usage in *immersive* situations.

With the next most prominent theme—*navigation*—participants spoke of using the interface to seek out *specific* sites. Then, similarly, with the theme of *general wayfinding*, participants spoke of using the interface in order to support general, situational decision-making. Both of these themes were seen to suggest usage in *prosaic* situations.

Lastly, with the theme of *orientation in relation* participants spoke of how the interface might be used to reference or to relate to features in the surrounding environment. As there was a clear environmental focus in these contributions, the theme was seen to suggest usage in immersive situations.

Reflecting on the above, as the themes of *touring* and *exploration/wandering* together are dominant, we may conclude that a majority of participants ascribed meanings to the interface which suggest usage in immerse scenarios. As such, it would appear that a majority have envisioned a use-context wherein the user is likely to be keenly aware of the surrounding environment, as well as their embodied involvement within it.

It is notable that EP#22, EP#25, EP#26, EP#33 and EP#34 did not suggest any uses, which would point to their having sensed that the interface might be applied in *immersive* situations (i.e. their references relate only to the themes of *general wayfinding* or *navigation*). We will consider these cases in more detail in Chapter 6 (see Section 6.1.2.1).

We have now outlined the results of analysis of the interview data, i.e. the qualitative data. These results will be dealt with further in the next chapter, as we move to assess the integrated dataset for the support of SA-in-use. For now we turn to discuss the analysis of the observation data, i.e. the quantitative data, focusing on participants' I-E interactions.

5.4.5 *Results of the Analysis of Participants' Interface-Environment Interactions*

Through video recording, observations were made of participants' behaviour with Google Maps in the orientation task, and their emergent use of the prototype interface on the walk. This was undertaken with a view to detecting any differences in the I-E interactions observed with the prototype when set against those observed for Google Maps. (For an outline of the method applied here see Section 3.3.8.2). In framing this, the researcher decided that in order to legitimately consider participants' two sets of behaviours next to one another (i.e. their use of both interfaces), it would be necessary to identify and isolate a credible point within participants' prototype use against which such a comparison might take place.

In the end, participants' *first use* of the prototype was seen to present such a point. Here, it was felt that participants were likely to be *as aware* of being 'tested', and so *as* affected in their behaviour, as they had been when they used Google Maps. In other words, a similar level of self-consciousness was likely to be shaping their I-E interactions at this point.

Having reasoned thus, each participant's first instance of use of the prototype was identified and isolated. Here, in each video recording, the researcher sought out the first point at which the participant was seen to *look down* at the prototype interface and would then sample the participant's use[4], i.e. observe their interactions, for one minute.

In observation, the researcher attended to the *amount* of times participants looked up from the interface (i.e. the frequency), as well as the total *length* of time participants looked up for (i.e. the duration). A variance analysis was then performed on the data.

The results are set out on the table below. It should be noted that in the case of EP#29, the recording of her Google Maps use failed. From memory, the researcher was able to recall the amount of times this participant looked up (i.e. the frequency), but it wasn't possible to register the length of time (i.e. the duration) of these gazes/glances. Consequently, this participant's data has not included in the quantitative analysis conducted below. However, she is drawn back in as we move *qualitize* the data in Section 5.4.5.1 (wherein numerical accuracy is no longer a key concern).

Variation in Participants' Behaviour When Using Google Maps and the Prototype

EP No.	Frequency of Upward Glances/Gazes		Duration of Upward Glances/Gazes		Variation Results in Relation to the Prototype Interface	
	Google	Prototype	Google	Prototype	Frequency	Duration
EP#16	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included
EP#17	0	1	0 sec	2 sec	+1	+2 sec
EP#18	0	6	0 sec	20 sec	+6	+20 sec
EP#19	1	7	2 sec	32 sec	+6	+30 sec
EP#20	0	1	0 sec	8 sec	+1	+8 sec
EP#21	0	8	0 sec	36 sec	+8	+36 sec
EP#22	0	2	0 sec	35 sec	+2	+35 sec
EP#23	7	3	5 sec	23 sec	-4	+18 sec
EP#24	0	7	0 sec	38 sec	+7	+38 sec
EP#25	0	5	0 sec	26 sec	+5	+26 sec
EP#26	2	3	2 sec	39 sec	+1	+37 sec
EP#27	0	11	0 sec	22 sec	+11	+22 sec
EP#28	1	7	1 sec	15 sec	+6	+14 sec
EP#29	4* [Recalled from Memory]	11*	Data lost	35 sec*	N/A	N/A
EP#30	1	12	5 sec	31 sec	+11	+26 sec
EP#31	0	8	0 sec	38 sec	+8	+38 sec
EP#32	6	6	8.5 sec	39 sec	+0	+30.5 sec
EP#33	0	7	0 sec	17 sec	+7	+17 sec
EP#34	4	9	8 sec	17 sec	+5	+9 sec
EP#35	0	5	0 sec	41 sec	+5	+41 sec
EP#36	5	6	11 sec	31 sec	+1	+20 sec
	Median Value	Median Value	Mean Value	Mean Value	Median Value Derived	Mean Value Derived
	0	6	2.81 sec	26.84 sec	+5	+24.6 sec

* Due to a recording failure, it is not possible to include EP#29's Google Maps task results in the above table. The researcher was however able to recall from memory that the participant looked up 4 times and did so for extended periods. As such the results are presented here but not included within the quantitative analysis. Below, as the results are qualitized they are again drawn in (see Section 5.4.5.1, below).

Table 5.19 The data relating to participants' upward gazes/glances and the length of these upward glances/gazes. At the bottom, the results of analysis of the particular behaviours are set out along with the across-series variance analysis (on the right).

From the above table, we may observe a notable divergence in participants' behaviour in each part of the test (i.e. in their use of Google Maps and the prototype).

Turning first to the *frequency* of participants' upward glances/gazes with Google Maps, we see that 11 (of 19) participants did not look up at the surrounding environment in the orientation task. Of those who did look up, we see that they did so a minimum of 1 time and maximum of 7 times. Here, a median value of 0 upward glances/gazes is derived.

With the prototype, 19 (of 19) participants looked up at least 1 time during this minute sample of their use. The maximum number of upward glances/gazes was 12. Here, a median value of 6 upward glances/gazes is derived.

When directly comparing the frequency of participants' upward glances/gazes in both parts of the test through variance analysis, we find that a median value of 5 *additional* glances/glazes have been observed in participants' use of the prototype. Below, two bar charts (one for Google and one for the prototype) present the distribution of the amounts of upward glances/gazes (i.e. how many participants looked up a particular number of times).

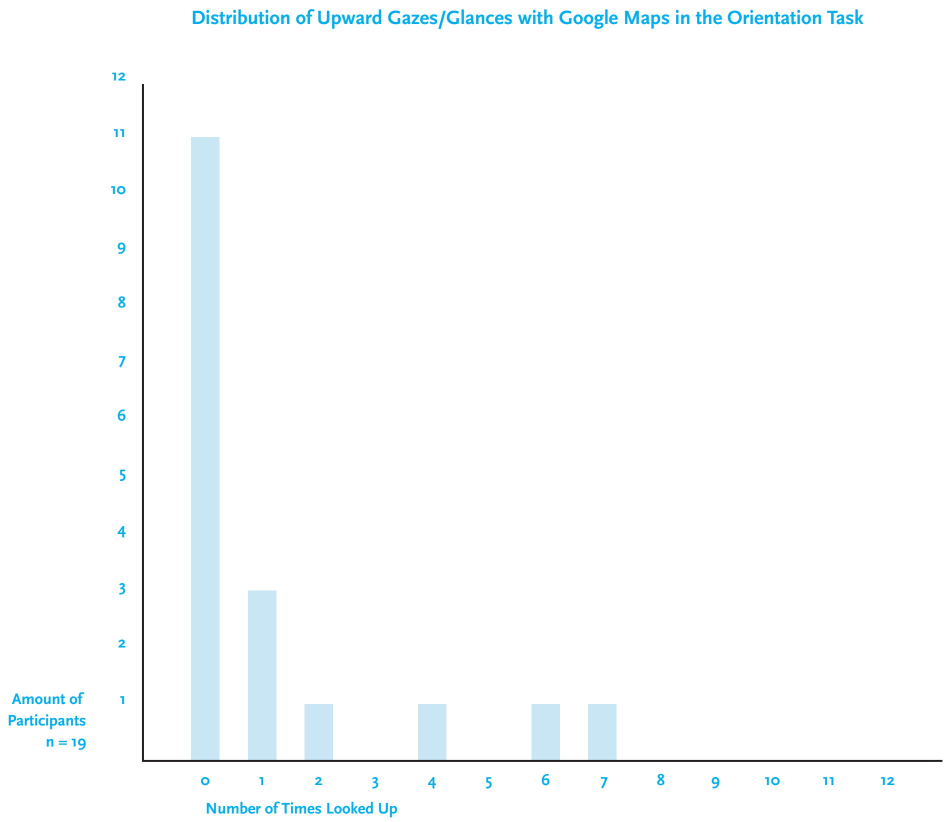


Fig. 5.41 The distribution of upward glances/gazes with Google Maps (i.e. how many participants looked up a particular number of times).

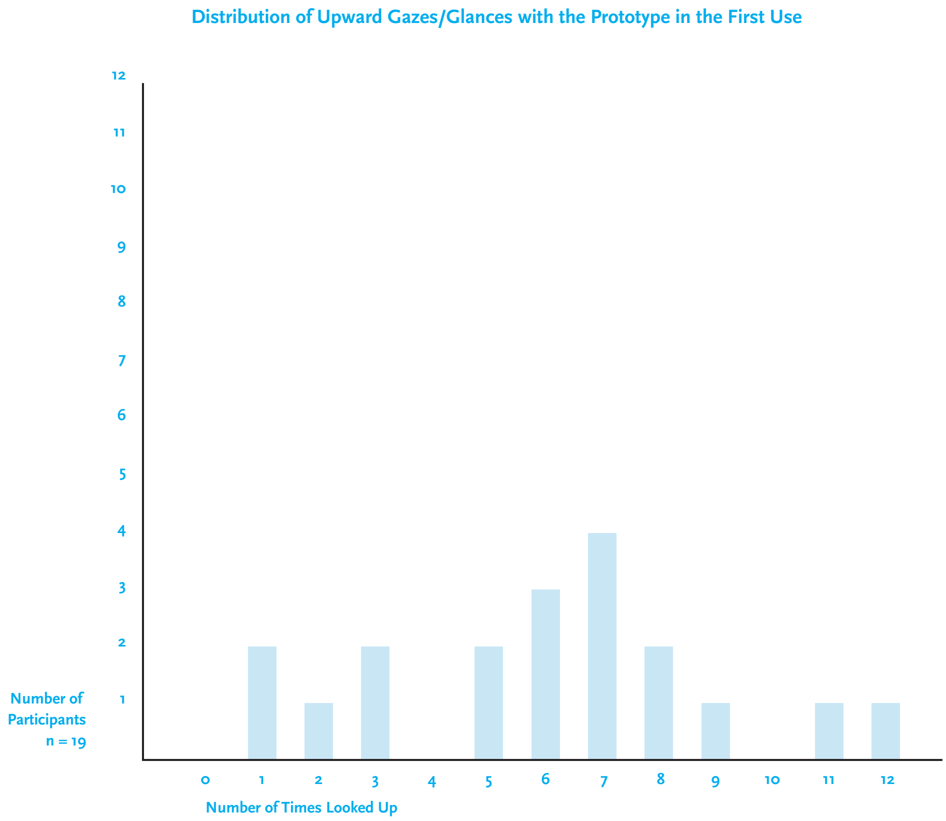


Fig. 5.42 The distribution of upward glances/gazes with the prototype (i.e. how many participants looked up a particular number of times).

A similar trend will be observed if we consider the total amount of seconds participants looked up for from each interface, i.e. the total *duration*.

With Google, for the 8 (of 19) participants who do look up, the minimum duration is 1 second and the maximum is 7 seconds. However, as most do not look up, a median value of 0 seconds is derived across the series. With the prototype, for the 19 (of 19) who do look up, the minimum duration is 2 seconds and the maximum is 41 seconds. Here, a mean value of 26.84 seconds is derived.

Thus, when directly comparing the duration of participants' upward glances/gazes in both parts of the test through variance analysis, we find that a mean value of 24.6 *additional* seconds have been observed in participants' use of the prototype.

Below, in figure 5.43 we see two box-plots of the total duration of participants' upward glances/gazes—one for participants' use of each interface—set along the same scale.

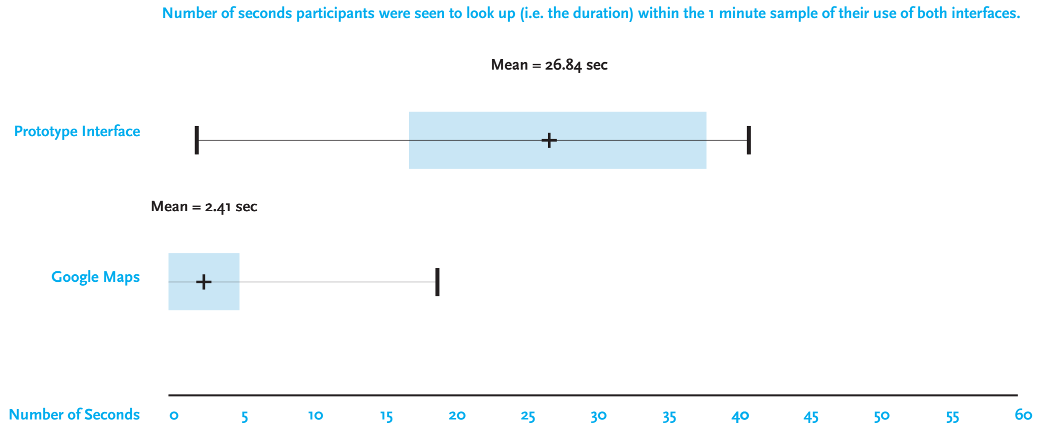


Fig. 5.43 A comparison of the total amount of seconds (i.e. the duration) that participants were seen to look up from each interface within the minute samples of their use.

Grouping both sets of results, we may say that participants were inclined to look away *more* and look away for *longer* in their emergent use of the prototype, over their use of Google Maps in the orientation task. As such, we may conclude that participants are displaying a higher overall level of I-E interactions in their emergent use of the prototype, over their use of Google Maps in the orientation task.

From the above, we now move to qualitize (i.e. convert into qualitative form) the above results in order that they may be integrated with the previous qualitative results derived from the interview data. This will allow us to conduct an assessment of SA-in-use (see Sections 5.4.4 and 3.3.9) in Chapter 6 (see Section 6.1.2), which, in turn, allows us to ascertain whether or not the design hypothesis has been verified.

5.4.5.1 *Qualitizing the Quantitative Observation Data*

In the *qualitization* of the quantitative data (i.e. its conversion into qualitative form; see Section 3.3.8.3 for an outline of method), the frequency and duration of participants' upward glances/gazes were processed separately. In this, as it was possible to recollect the shape of participant EP#29's Google Maps use, her results were included and, so, qualitized[5] (see Section 5.4.5 above).

In order that qualitization be standardised and, as such, uniform it was necessary to develop a consistent approach.

With frequency, it was decided that the *temporal distribution* of participants' upward glances/gazes would be examined. Here, four possible levels of frequency were decided upon: not looking up, looking up *infrequently*, looking up *frequently*, and looking up *throughout*. In order to distinguish whether a participant looked up *infrequently*, *frequently* or *throughout*, each participant's sample of use was divided into three *even* sections. This allowed the researcher to examine the temporal distribution of gazes/glances across the sample in a consistent fashion. Appendix E presents the material, which supported this process (i.e. graphs of each participant's set of I-E interactions).

In examining the sample, if a participant was seen to glance upwards in *only one* section it could be said that a participant looked up 'infrequently'. Alternatively, if the participant was seen to look up in *two* sections then it could be said that a participant looked up 'frequently'. Lastly, if the participant was seen to look up in *every* section, then it could be said that they looked up 'throughout'.

Most often with Google, participants did not look up. Thereafter, three participants looked up infrequently, two participants looked up frequently and, lastly, only one participant, EP#36, was seen to look up throughout.

Conversely, with the prototype, most participants are seen to look up throughout. Thereafter, four participants were seen to look up frequently and two participants were seen to look up infrequently.

As a next step, the *duration* of participants' upward glances/gazes was qualitized. Here, one of two possible categories was applied. Participants were said to have either looked up extensively or inextensively.

In order to distinguish whether a participant looked up *extensively* or *inextensively*, the total *number of times* participants looked up (i.e. the frequency) was divided by the total amount of time they spent looking up. If the result obtained exceeded the *number of times* participants looked (i.e. the frequency) by *one and a half* it was then said that they looked up *extensively*. If not, they were said to have looked up *inextensively*. This approach to the qualitization of duration was seen as reasonable on the basis that if participants were regularly looking up for *more* than a *second* then their gaze was likely to be purposeful rather than unconscious. In other words, they were *gazing* at the surrounding environment rather than simply *glancing*.

As before, with Google, most participants did not look up. Thereafter, five participants were seen to look up *extensively* and four *inextensively*. Then, with the prototype *all* participants were seen to look up extensively.

Grouping the above sets of qualitized results, we may conclude by saying that most participants were seen to look up *throughout* and *extensively* with the prototype, while most participants *did not look up* with Google Maps.

Thus, we have presented both the qualitative and quantitative results of the prototype test, as well as the results of qualitization (i.e. the conversion of the quantitative data into qualitative form). In the next chapter these results will be integrated (i.e. the qualitative and (qualitized) quantitative data). This will allow for the assessment of whether or not SA-in-use had been supported against the statement set out in relation to this in the conceptual framework (see Section 2.4). Such an assessment will, in turn, make it possible to ascertain whether or not the design hypothesis has been verified.

Summary

This chapter has provided an overview of the second phase of the research, where a series of design experiments were conducted in order to develop a *novel* GPS-enabled WI in response to the design hypothesis of the first phase. The chapter was divided into four sections.

In the first section, preliminary design work was discussed. Here, the Apple Corporation's iPhone 4S was selected as the enquiry's test platform. Additionally, the interface design features that were seen to converge in early sketches were also discussed.

Then, in the second section, the exploratory designs were set out. Here, through the development of a number of arrays of alternative designs, the features that were seen to converge within the preliminary design work were refined.

From this, in the third section, the field simulation test was discussed. Here, building on the work undertaken in exploratory designs, *simulated* interfaces were trialled in 'natural' settings of use, i.e. in outdoor urban locations in Glasgow. Qualitative and quantitative methods of data collection and analysis were applied. Here, qualitative data was collected as participants openly evaluated the FS designs. The results of analysis of this data were seen to enable the iteration of the designs. In analysis of the whole dataset, it was found that, despite some objections, the essential features of the FS designs appealed to many participants. Alongside this, quantitative data collection and analysis focused on participants' behaviours in two orientation tasks, one with Google Maps and one with the prototype. Herein, the researcher considered the amount of times participants looked up and turned their bodies in the tasks. It was found that, participants were seen to look up and turn their bodies *more* often while using the FS designs over Google Maps. The results of qualitative and quantitative analysis, combined with the recognition that the features of the FS designs had begun to converge (by FS#7), informed the researcher's decision to move to develop a mixed-fidelity working prototype.

Thus, in the fourth section, the design of the mixed-fidelity working prototype was described. From this, the results of the prototype test were set out. Here participants were given an orientation task with Google Maps and then asked to 'use' the prototype twice while walking along a test-route. Again, qualitative and quantitative methods were applied.

Qualitative data was collected through semi-structured interviews looking at: participants' *experiences with* the prototype (i.e. what happened); their *experiences of* both interfaces (i.e. what each was *like*); their *information design experience* and the *meanings* they ascribed to the prototype (i.e. what they thought it was for).

In qualitative analysis the researcher first assessed whether or not participants' *experiences with* the prototype suggested that exploratory wayfinding might still be possible by seeking to match extracts of participants' descriptions to the components of exploratory wayfinding as defined in Section 4.2.2. Assessment revealed that all but two participants within the group were seen to have had experiences that could be reasonably matched to the components of exploratory wayfinding. Therefore, the results suggested that exploratory wayfinding practices were still possible in use.

Next in analysis of participants' *experience of* both interfaces it was found that with the prototype, a slight majority of participants appear to have taken an *environmental focus*, i.e. spoke of the interface in terms relating to the surroundings or the wider context. Conversely, with Google maps, a majority of participants took an *interface focus*, i.e. they spoke of the interface almost exclusively in terms of the visuals or the interactivity.

With regard to their *information design experience*, participants were seen to make reference to the interface on three separate levels: the whole interface; particular features of the interface; and the properties of particular features. With regard to the whole interface, the themes of *direction-based* and *clear/simple* emerged prominently. In regard to particular features, the *symbols* and the *inclusion of the monuments* emerged as key themes. In regard to the latter, it seemed that, for some, the inclusion of the monuments in the design had enriched their experience. Then, with the properties of particular features, many participants were seen to identify a link between the information presented on screen and that which was represented.

Lastly, in analysis of the meanings participants' ascribed to the interface, the themes of *touring* and *exploration/wandering* emerged most prominently. These themes were seen to suggest usage in immerse situations. That is, situations wherein the user is likely to be keenly aware of the surrounding environment, as well as their embodied involvement within it.

Quantitative results arise from a comparison of participants' use of Google Maps in the orientation task, set next to their first use of the prototype on the test-route. Here, it was shown that participants were inclined to look away *more* and look away for *longer* with the prototype, over Google Maps. Thus, it was concluded that participants were displaying higher overall levels of I-E interactions in their emergent use of the prototype, over their use of Google Maps in the orientation task.

The latter results were then qualitized (i.e. converted into qualitative form). Through qualitization, the quantitative results were reframed as follows: with the prototype most participants were seen to look up *throughout* and *extensively*; conversely with Google Maps most participants *did not look up*.

Endnotes

1. It should be noted that the terms applied within Elias and Paelke's scale (e.g. sketch) are not seen as helpful in that they do not appear to reference any prior work on the classification of pictorial representations and so seem arbitrary. Thus it must be emphasised that the scale has been applied here solely as a tool with which to guide the design of alternative visualisations. (For a detailed discussion on the classification of types of correspondence see Engelhardt 2002:97-115).
2. It must be noted that in the assigning of 'significance' to particular elements of Glasgow, the researcher sought to exercise reasonable judgement. Over the development of the FS designs a consistent use of a number of elements were employed (e.g. the city centre, the river Clyde, Kelvingrove Park). Interestingly, no objections were raised regarding the selection of particular content for inclusion.
3. Due to the exclusion of streets and roads from the interface, these were not given extensive consideration in the interpretive process.
4. Alternatively, if the participant claimed to have experienced technical difficulties up until a particular point, this particular instance of use was then sought out within the video and subsequently observed. This was the case with participants EP#20, EP#24 and EP#32.
5. As was stated in Section 5.4.5, the recording of EP#29's Google Maps use failed. The researcher was however able to recall the number of times she looked up as well as a general sense of how extensive these gazes were.

6.
A Novel Graphic Syntax: An Artefact, a Framework Extension and a Contextualisation

In the last chapter, the results of the design experiments, including the qualitative and quantitative results of the prototype test, were set out. In this chapter, the latter qualitative and (qualitized) quantitative results are integrated and assessed for the support of situation awareness in use (SA-in-use). Such an assessment makes it possible to ascertain whether or not the design hypothesis has been verified.

The chapter is divided into four sections. In the first section, the prototype test results are integrated and assessed for SA-in-use, allowing for the verification of the design hypothesis. Then, in the second section, having verified the hypothesis, the prototype interface is presented as a *practical response* to the first research question (see Section 1.1) and, as such, one of the enquiry's major contributions. Next, in the third section, the process of graphic syntax definition is set out. Here, a graphic syntax analysis of the interface is conducted so as to better define its information design features. From this, a reflection on the applicability of Engelhardt's graphic syntax framework (2002) to the dynamic and interactive aspects of graphic representations is offered. This leads to a proposed extension of the framework, which is identified as another major contribution of the enquiry. Lastly, the fourth section draws the whole together as the newly defined graphic syntax is contextualised and thereafter presented. This contextualised graphic syntax is seen to annotate the artefact and, so, offer a set of principles for the design of a GPS-enabled wayfinding interface to visually support an urban recreational walker's/wanderer's SA-in-use. It is offered as the final major contribution of this enquiry.

Below, in figure 6.1 a diagrammatic overview of this chapter is provided. It lists the flow from the integration of the prototype test results, through to the presentation of the final contextualised graphic syntax.

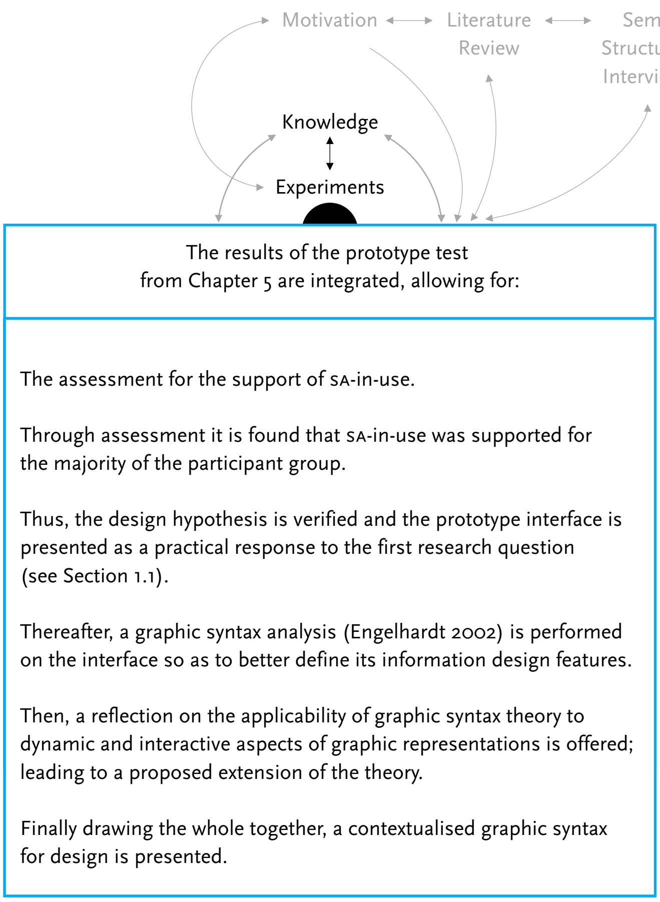


Figure 6.1 A diagrammatic overview of the flow of the latter stages of the enquiry.

6.1 Assessing for the Support of Situation Awareness in Use

The assessment for the support of SA-in-use among the prototype test participants involved two stages. Firstly, the qualitative and (qualitized) quantitative results from the prototype tests were integrated within a single table. Secondly, with this table to hand, the emergent patterns of experience and behaviour were assessed against the statement set out in relation to the support of SA-in-use in the conceptual framework (see Section 2.4).

6.1.1 *The Integrated Dataset: Revealing Patterns of Experience and Behaviour*

As a means of integrating the qualitative and (qualitized) quantitative results table 6.1 (below) was prepared. Here, from left to right, we find: each participants' *experiences of* both interfaces (i.e. the themes emerging from their accounts of what each was *like*), set alongside their interface-environment (I-E) interactions for both interfaces; their *experiences with* the prototype as they related to the components of exploratory wayfinding; and, finally, the *meanings* they ascribed to the prototype. Thus, for each participant, a pattern of experience and behaviour is revealed.

The Integrated Qualitative and (Qualitized) Quantitative Results of the Prototype Test

EP No.	Experience of Google Maps	I-E Interactions with Google Maps i.e. *Looking up*	Experience of the Prototype	I-E Interactions with the Prototype i.e. *Looking up*	Experiences with the Prototype	Meanings Ascribed to the Prototype
EP#16	Not Included	Not Included	Not Included	Not Included	Not Included	Not Included
EP#17	Route-Based	Did Not Look Up	General Relationality	Infrequently and Extensively	Noticing, Directional Movement	Exploration/ Wandering
EP#18	Non-Egocentric	Did Not Look Up	Egocentric Relationality	Throughout and Extensively	Noticing	Orientation in Relation
EP#19	None	Infrequently and Extensively	Egocentric Relationality	Throughout and Extensively	Noticing, Directional Movement	Touring, Navigation
EP#20	Offers a Wider Context	Did Not Look Up	Immediate Relationality	Throughout and Extensively	Noticing	Exploration/ Wandering
EP#21	Route-Based	Did Not Look Up	Immediate Relationality	Throughout and Extensively	Directional Movement	Exploration/ Wandering
EP#22	Challenging in Orientation Graphically Dense	Did Not Look Up	Immediate Relationality	Infrequently and Extensively	Noticing	General Wayfinding
EP#23	Challenging in Orientation	Throughout and Inextensively	Immediate Relationality	Frequently and Extensively	Noticing	Touring
EP#24	Limited Representation	Did Not Look Up	Immediate Relationality	Throughout and Extensively	Noticing	Touring, Exploration/ Wandering
EP#25	Graphically Dense	Did Not Look Up	Immediate Relationality	Throughout and Extensively	Noticing	Navigation
EP#26	Metric Representation	Frequently and Inextensively	None	Frequently and Extensively	Emergent Paths	Navigation
EP#27	Challenging in Orientation	Did Not Look Up	Direction-Based Relationality	Throughout and Extensively	Noticing	Orientation in Relation
EP#28	Information Rich	Infrequently and Inextensively	Direction-Based Relationality	Throughout and Extensively	Directional Movement	Touring
EP#29	Non-Trustworthy	Throughout and Extensively [Estimated]	Egocentric Relationality Immediate Relationality	Throughout and Extensively	Finding/ Serendipity	Exploration/ Wandering
EP#30	Rich Interactivity	Infrequently and Extensively	Compelling Novelty	Throughout and Extensively	[None]	Navigation
EP#31	Route-Based	Did Not Look Up	General Relationality	Throughout and Extensively	Noticing	General Wayfinding
EP#32	Graphically Dense	Throughout and Inextensively	Direction-Based Relationality	Frequently and Extensively	Noticing	Touring
EP#33	Route-Based	Did Not Look Up	Non-Route Based	Throughout and Extensively	Noticing	General Wayfinding
EP#34	Offers a Wider Context	Frequently and Extensively	Ambiguous Directionality	Throughout and Extensively	[None]	General Wayfinding

EP No.	Experience of Google Maps	I-E Interactions with Google Maps i.e. *Looking up*	Experience of the Prototype	I-E Interactions with the Prototype i.e. *Looking up*	Experiences with the Prototype	Meanings Ascribed to the Prototype
EP#35	Route-Based	Did Not Look Up	Immediate Relationality	Frequently and Extensively	Noticing	Touring
EP#36	Non-Egocentric	Throughout and Extensively	Egocentric Relationality Immediate Relationality	Throughout and Extensively	Noticing	Touring, Orientation in Relation

Table 6.1 The integrated qualitative and (qualitized) quantitative results from the prototype tests. Here, from left to right, we see: each participants' experiences of both interfaces (i.e. the themes emerging from their accounts of what each was like), set alongside their interface-environment (I-E) interactions for both interfaces; their experiences with the prototype as they related to the components of exploratory wayfinding; and, finally, the meanings they ascribed to the prototype.

Tracing through the above patterns, a series of related observations are made. First, it is noted that, across the group, participants' I-E interactions appear to be relatively consistent. Here, with the prototype, we see that most participants looked up *throughout* and *extensively* or else *frequently* and *extensively*. Conversely, with Google Maps, most *did not look up*.

From this, if we turn to examine participants' experiences of the both interfaces, this consistency is not matched. In other words, when participants exhibited high I-E interactions with the prototype and did not look up with Google, no one particular theme is seen to accompany such behaviour.

Despite this, it is possible to state that, as was identified in the last chapter (see Section 5.4.4.2), a slight majority of the group were seen to speak of the prototype in terms relating to the themes of *immediate relationality* and *general relationality*. That is, in describing their experience of the prototype, a slight majority of the group took an *environmental focus*. While no overarching theme emerged in relation to Google, it was identified that the vast majority of themes suggested an *interface focus* (e.g. *route-based* and *graphically dense*).

Thus, we can now say that the *environmentally focused* themes of *immediate relationality* and *general relationality* often accompany I-E interactions with the prototype wherein the participant looks up *throughout* and *extensively* or else *frequently* and *extensively*. Then *interface focused* themes (e.g. *route-based* and *graphically dense*) often accompany I-E interactions with Google Maps wherein participants *did not look up*.

As the themes of *immediate relationality* and *general relationality* were seen to suggest an environmental focus it would appear that, in these cases, the prototype was understood, i.e. its representation made sense. This is reinforced by the observation that most of these participants had *experiences with* the prototype, which suggested that they were *noticing* things as they walked.

Thus, with participants who had *experiences of* the prototype relating to the themes of *immediate relationality* and *general relationality*, it would appear that the high levels of I-E interactions observed are at least partly attributable to the interface's *design*.

This leaves us with a question regarding the remainder to the group; namely, are the high levels of I-E interactions observed here at least partly attributable to the interface's design?

Surveying the table we see that a sizable number of participants, who looked up *throughout/frequently* and *extensively* with the prototype, had experiences of the interface relating to the themes of *direction-based relationality* or *egocentric relationality*.

We will now consider these two groups more closely.

With the theme of *direction-based relationality* it will be recalled that participants referred to the interface in terms of how its directional approach to representation allowed them to relate to other features. Then, with the theme of *egocentric relationality*, it will be recalled that participants referred to their position being privileged in relation to other features. Both of these themes were seen to suggest an *interface focus*. Thus, while these participants appear to understand the interface (i.e. they recognise its orientational format or can identify their position within it), their I-E interactions are not automatically attributable to the design. However if we look to the sixth column, and examine these participants' *experiences with* the prototype we see that all but one, EP#28, speak of *noticing* things in their use of the prototype. As such, it would seem that they were drawing links between the interface and the environment. Indeed, in outlining their information design experience, both EP#19 and EP#28 were seen to identify a link between the information presented on screen and that which was represented (see Section 5.4.4.3). Furthermore, all of the meanings these participants attributed to the interface (i.e. *touring* or *orientation in relation*) hint at uses in *immersive* situations. Thus it would appear likely that the interface was understood and, though an *interface focus* is suggested by the themes, the level of I-E interactions observed are at least partly attributable to the interface's *design*.

From the above, there remain a number of outstanding cases wherein participants have exhibited high I-E interactions but their *experiences of* the prototype do not provide us with a clear insight into their behaviour. For this group, the interface is experienced as respectively offering only: *compelling novelty* for EP#30, *non-route based representation* for EP#33 and *ambiguous directionality* for EP#34. Additionally, EP#26 implied that the interface offered non-metric representation against the *metric representation* afforded by Google Maps. This ambiguity is reflected in these participants' meanings, where they propose that the interface might be applied as an aid in *navigation* or simply in *general wayfinding*, i.e. they suggest uses in *prosaic* situations. Additionally, EP#30 and EP#34 do not appear to have had *experiences with* the prototype, which could be matched to a component of exploratory wayfinding (as was pointed out in Section 5.4.4.1). We will deal with these cases in the next section.

For now, we will return to our overall consideration of participants' patterns of experience and behaviour with both interfaces and make a series of concluding statements.

Firstly, in the Google Maps orientation task it appears that in exhibiting low I-E interactions the majority of participants took an interface focus. As such, it would seem that in exhibiting low I-E interactions, their attention was directed almost exclusively towards the information presented on screen. Secondly, in exhibiting high I-E interactions in their emergent use of the prototype it appears that a majority of participants took an *environmental* focus. Here, the view was taken that the prototype was likely to have been understood and that the high levels of I-E interactions exhibited were likely to be at least partly attributable to the design. Thirdly, some participants exhibited high I-E interactions in their emergent use of the prototype, yet took an *interface focus*. Here, through close analysis, it was determined that these participants were still likely to have understood the interface. Additionally, it was also shown that the high levels of I-E interactions exhibited were likely to be at least partly attributable to the design. Thus, taking the Google Maps orientation task as a contrasting baseline profile, the prototype appears to have supported meaningful higher I-E interactions for a majority of the group. Having set out the above overview, it is now possible to assess whether or not the prototype interface may be seen as having supported SA-in-use among the group.

6.1.2 *Assessing for the Support of Situation Awareness in Use Across the Group*

In assessing for the support of SA-in-use with the prototype, it is necessary to return the statement concerning the subject set forth in the conceptual framework (see Sections 2.4 and 2.3.7). Arising out of previous definitions of wayfinding and SA, this statement provides us with criteria against which we might reasonably assert that SA-in-use was supported. It reads as follows: if a walker's/wanderer's situation awareness was supported in their use of a GPS-enabled wayfinding interface, the walker/wanderer would

> *remain aware of their embodied involvement in the surrounding environment, by continuing to apply embodied perception and embodied understanding in linking together and comprehending a series of seen vistas.*

In assessment, we refer to the patterns of experience and behaviour set out above in Section 6.1.1. As it was shown that participants looked up throughout and extensively or frequently/infrequently and extensively with the prototype, we can reasonably assert that *all* participants were seen to *continue to apply embodied perception and embodied understanding in their use of the prototype.*

Next, as a majority of participants' *experiences* of the prototype related to the themes of *immediate relationality* and *general relationality*, it would appear that these participants' high I-E interactions are at least partly attributable to the interface's design. Thus, we can reasonably assert that they are likely to have remained *aware of their embodied involvement in the surrounding environment* in use.

In addition to the above, for those participants who experienced the prototype exclusively in terms of the themes of *direction-based relationality* and *egocentric relationality*, it was also shown that the I-E interactions exhibited were likely to be at least partly attributable to the interface's design. As such, we can here again reasonably assert that they are likely to have *remained aware of their embodied involvement in the surrounding environment* in use.

Thus, reflecting on these combined patterns of experience and behaviour, we can say that, in the majority of cases with the prototype, participants appear to have *remained aware of their embodied involvement in the surrounding environment* as they were *continuing to apply embodied perception and embodied understanding*. Therefore, against our criteria, we can say that in the majority of cases across the group it appears that SA-in-use was supported with the prototype.

Based on the above, it now possible to assert that the design hypothesis (see Section 4.3) has been verified.

However, as was already noted, there remains a group of participants who do not meet the criteria. These participants continued to apply *embodied perception and embodied understanding* in use (i.e. they exhibited high I-E interactions). But they do not appear to have experienced the interface in ways suggesting that they remained *aware of their embodied involvement in the surrounding environment* in use.

Thus, we are presented with a number of negative cases, which must be understood before we proceed.

6.1.2.1 *Understanding Cases Where Situation Awareness in Use was Not Supported*

In order to gain an understanding of the negative cases presented by EP#26, EP#30, EP#33 and EP#34, each will be briefly considered in turn. From this, we will then discuss any patterns that are seen to emerge.

Beginning with EP#26, we see that she looked up frequently and extensively with the prototype and frequently and inextensively with Google Maps. When discussing Google Maps, she spoke of how she was able to visually estimate distances, i.e. *metric representation*. In doing so, she appeared to imply that, with the prototype, it wasn't possible to visually estimate distances through the representation.

EP#30 looked up *throughout* and *extensively* with the prototype and *infrequently* and *extensively* with Google. In making reference to her experience of the prototype, EP#30 focused on how she found it compelling and novel. With Google Maps, on the other hand, she could 'play around or change things up a bit…' (i.e. the theme of *rich interactivity*).

EP#33 looked up *throughout* and *extensively* with the prototype and *did not look up* with Google Maps. The prototype was framed in terms of its lack of routing information (i.e. the theme of *non-routed based*), while Google Maps was seen to offer 'point A to point B' (i.e. the theme of *route-based*).

Lastly, EP#34 looked up *throughout* and *extensively* with the prototype and frequently and extensively with Google. She felt that the interface offered only an ambiguous sense of direction (i.e. the theme of *ambiguous directionality*). Google Maps, on the other hand was seen to offer 'all the direction' (i.e. the theme of *offers a wider context*).

Reviewing the above, it is striking that participants appear to discuss the interfaces in oppositional terms. For the most part, the prototype is seen as deficient in comparison to Google Maps. EP#26 misses being able to estimate distance. EP#33 prefers being able to see the wider context. EP#34 prefers a route-based design. Even EP#30 seems to prefer the richer interactivity of Google Maps, despite claiming to have experienced the prototype as compelling and novel. Thus, in each of the above cases, it would appear that the prototype is seen to lack the *expansive* content and/or interactivity offered by the conventional interface.

In seeking to interrogate the cases further, it will be helpful to consider participants' level of familiarity with the test-route as well as their urban recreational walking/wandering practices (set out in Section 5.4.2). Looking first to the group's familiarity with the test-route, it is noted that varying levels of familiarity are held within the group: EP#30 was quite familiar with the test-route; EP#33 and EP#34 held some familiarity; while EP#26 had no familiarity. Looking to the group's urban recreational walking practices a more coherent pattern emerges. Here, we see that all of the above cases only *occasionally* engage in urban recreational walking/wandering. In specific terms, a post-test conversation with EP#26 revealed that she did walk recreationally, but was not intrinsically motivated to do so. That is, her focus was not *to explore* or *to see* but rather to get *exercise*. Similar conversations with EP#30, EP#33 and EP#34 revealed that these participants did not walk recreationally in a local context (as had been the researcher's original understanding), but did do so when traveling. In this, they do not appear engage in exploration or wandering, but rather spoke of following pre-planned itineraries.

Thus, it would appear then that participants' level of familiarity with the test-route is not the critical factor affecting their *experiences* of the prototype. Rather, looking at the group's walking practices, we are provided with a set of key insights. As occasional recreational walkers/wanderers, who are either *extrinsically* motivated to walk or else follow pre-planned itinerates, the group appear to prefer the *expansive* content and/or interactivity of conventional interfaces. Accordingly, exploratory wayfinding practices and SA are not prioritised. From this perspective, it follows that any interface which allows for exploratory wayfinding practices, while also supporting SA-in-use, would not be seen to hold value. Thus, these participants fall outside the intended user-group and, consequently, their status as negative cases is resolved.

This completes our assessment of the support of SA-in-use. We are now able to present the prototype interface as a major contribution of the enquiry.

6.2 The Artefact: An Outline of the Prototype Interface

Having established that the design of the prototype interface is likely to have visually supported SA-in-use for a majority of the group (see Section 6.1 above), we are now in a position to claim that it presents a *practical response* to the first research question (see Section 1.1). That is, it may be seen to act as an *artefactual* example of how a GPS-enabled wayfinding interface (WI) can be designed to visually support an urban recreational walker's/wanderer's SA-in-use. Thus, it is presented as a major contribution of this enquiry.

6.2.1 The First Major Contribution: The Prototype Interface

In order to provide an outline of the interface and, as such, present it as a contribution, we will now explore the intended meaning of the general features of its structure. In doing so, for the sake of consistency, we will focus on a single static capture of the representation. Here, a screen shot from a section at the end of the test-route is selected for consideration on the basis that it includes the most comprehensive set of features of any possible static example.

Below, two figures offer an initial sense of this representation. Firstly, for clarity, in figure 6.2 it is shown in the abstract (i.e. on a wireframe mobile telephone). Then, in figure 6.3 it is shown photographically, in context, as it would have appeared to participants.

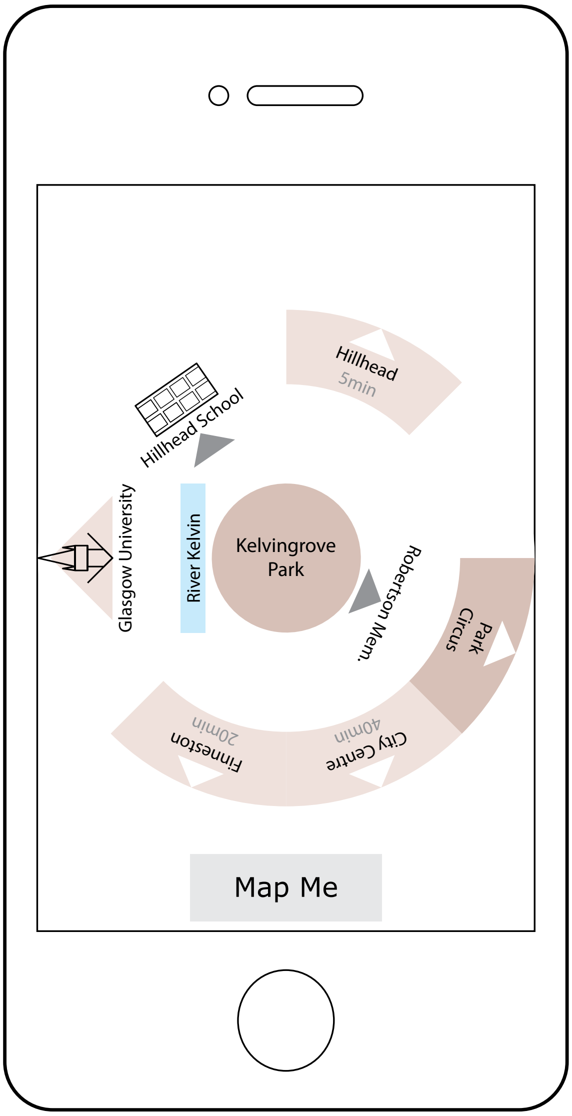


Figure 6.2 A screenshot of the prototype, showing a unique image/w1 on a wireframe mobile telephone. Here, the user's location is denoted by the large middle circle, with Kelvingrove Park inset. Around the centre near features are denoted through the use of small triangles. This is repeated for the representation of Hillhead school, shown as a pictorial landmark with a triangle beneath. Around the edge, triangles and wedges appear, representing the direction of features and districts respectively. At the bottom of the screen is the 'Map Me' button that the user was asked to press.

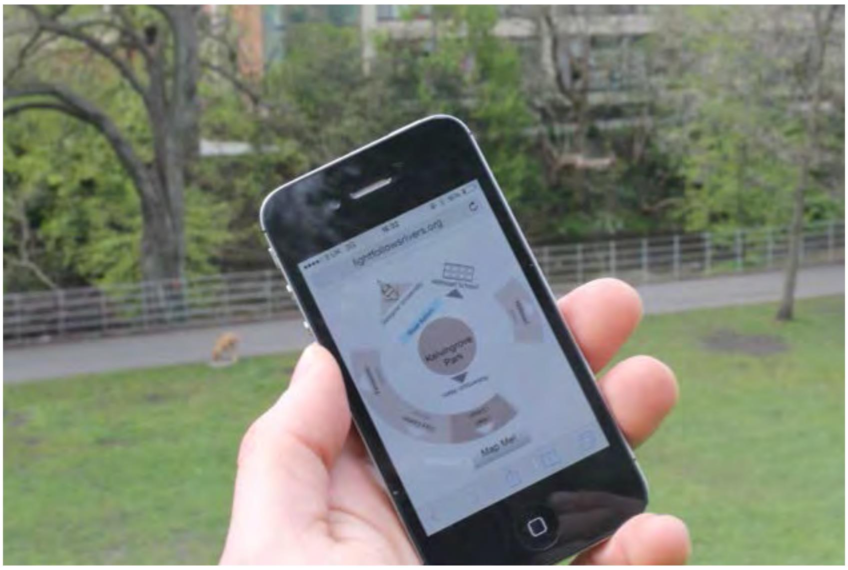


Fig. 6.3 The particular representation being considered in this outline of the visual design of the prototype, shown as it appears in context. Here, in the distance we see Hillhead school.

As we proceed through the outline which follows, it should be noted that the subsequent figures are shown as wireframes of the above. This is so as the interface's key features may be highlighted in their essential form.

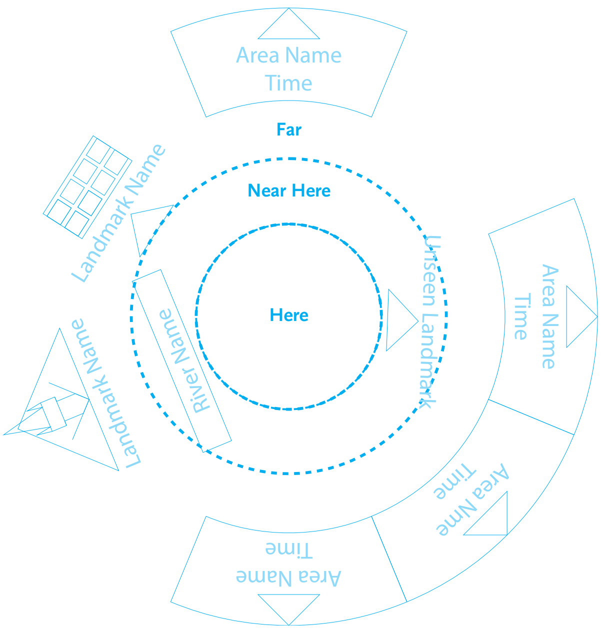


Fig. 6.4 Three separate levels of distances are denoted.

Above, in figure 6.4 we see that, through the staggered arrangement of the features, an attempt has been made to denote distances.

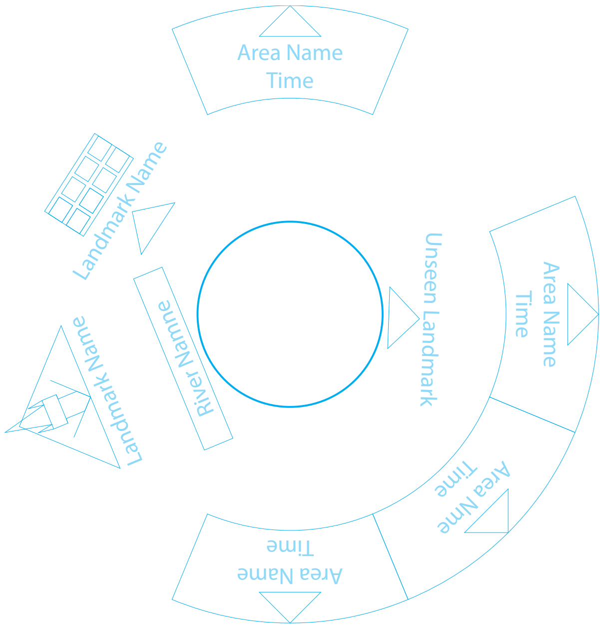


Fig. 6.5 The user's location at the centre of the interface.

Next, in figure 6.5, we see how the user's location is shown as a large circle.

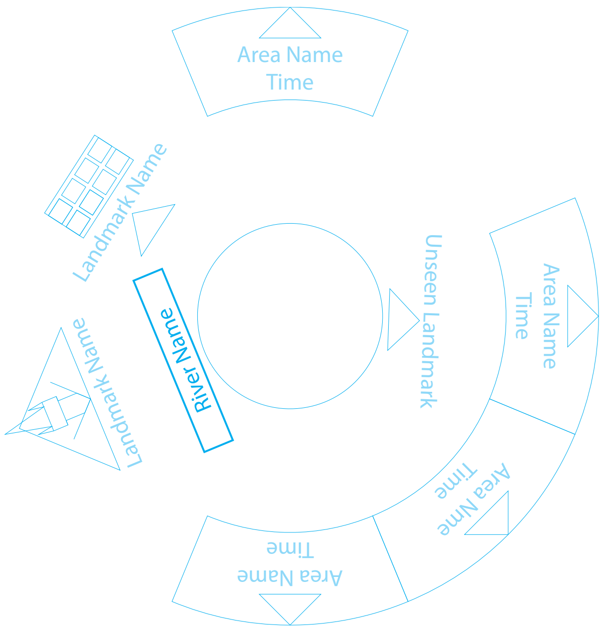


Fig. 6.6 A near linear feature; in this case, the river.

Then, above, in figure 6.6 a near feature (the river) is shown next to the user's location as a rectangular block.

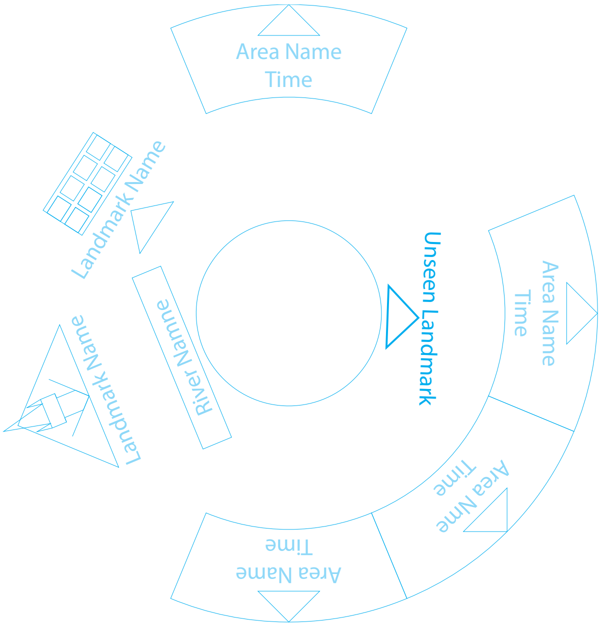


Fig. 6.7 An unseen landmark is highlighted with a triangle and text.

Above, in the right of figure 6.7, a non-visible landmark is identified with a triangle and text. As the user will not be able to look up and see it, it is shown without a pictorial representation. (This decision may be traced back to the open evaluations of FS#1.)

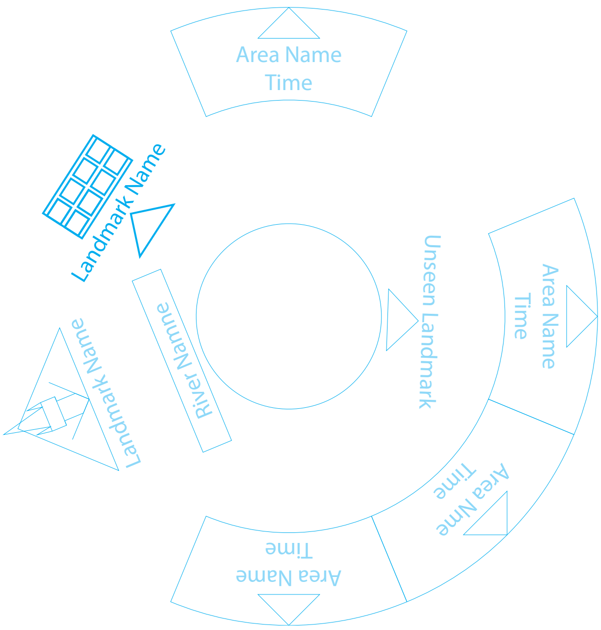


Fig. 6.8 A visible near landmark is highlighted with a triangle, text and a pictorial representation of a landmark.

Above, to the left, in figure 6.8, a visible *near* landmark is depicted with a simple pictorial representation, a triangle and text.

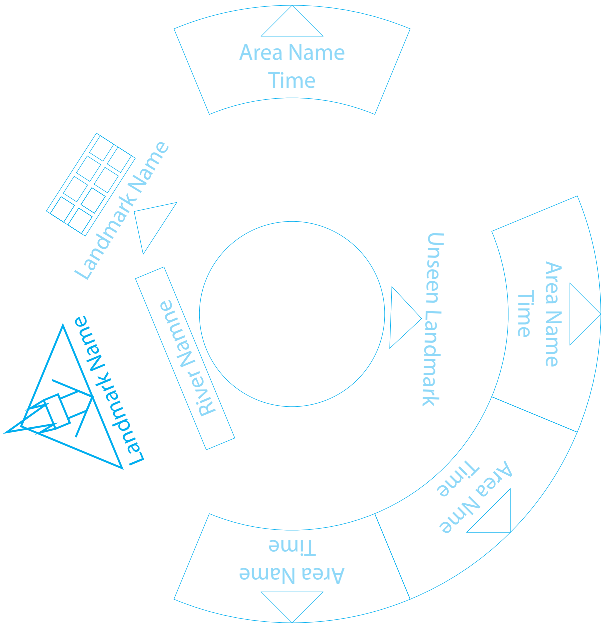


Fig. 6.9 A visible far landmark is highlighted by a triangle, with a pictorial representation inset and text below.

Above, on the left, in figure 6.9, a visible *far* landmark is depicted with a simple pictorial representation *contained in* a triangle and accompanied by text.

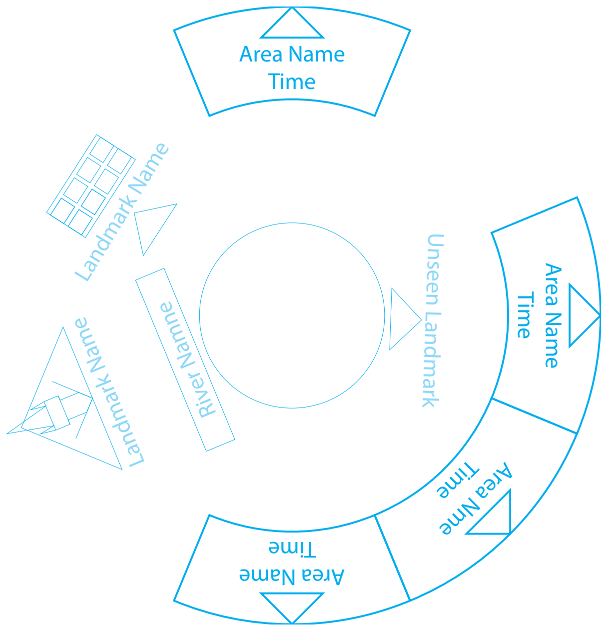


Fig. 6.10 Districts are highlighted around the edge, with text and triangles inset.

Finally, in figure 6.10 we see small 'wedge' shapes around the edge of the interface. These depict districts, containing text offering the district's name along with an estimation of how long it would take to reach the destination on foot.

Further to the above, for a more holistic and extensive illustration of the artefact, Appendix K offers a link to a video demonstrating the prototype in-situ (this may also be accessed on the Memory Key).

From this outline of the interface's features, we will now turn to look at the results of graphic syntax analysis, wherein the interface design's graphic syntax was defined.

6.3 A Graphic Syntax Analysis of the Prototype Interface

A graphic syntax analysis (Engelhardt 2002; see Section 2.1.5) was performed on the interface design in order that its graphic syntax might be defined and, later, presented within a *contextualised graphic syntax* (see Section 3.3.9). It was intended that this contextualised graphic syntax would act as an *annotation* (Gaver 2012) to the artefact (i.e. a major contribution of the enquiry) and, so, provide a set of principles for the design of a GPS-enabled WI to visually support an urban recreational walker's/wanderer's SA-in-use (see Section 3.1.2).

The results and implications of the analysis are detailed in the following sections.

6.3.1 The Results of a Graphic Syntax Analysis of the Prototype Interface

The graphic syntax analysis proceeded through four stages. In the first stage, what were perceived to be the interface's individual 'graphic objects' were isolated and, from this, the *relations* between these graphic objects were identified (see Section 2.1.5 for an outline of this approach). Thus, it was possible to interpret what Engelhardt terms the 'object-to-space relations' and 'object-to-object relations' (see Section 2.1.5.1). From this, in the second stage, an interpretation of the *syntactic roles* (see Section 2.1.5.1.1) played by these graphic objects and their relations took place. That is, efforts were made to identify the ways in which particular graphic objects were *meaningfully anchored* either *in* graphic space and/or *to* another graphic object. Then, in third stage, an interpretation of the types of correspondence and the modes of expression conveyed by the interface took place (see Section 2.1.5.2). Finally, in the fourth stage, drawing the above together, the interface was classified as a particular type of graphic representation (see Section 2.1.5.3).

In the following discussion general statements will be made in relation to what was revealed in analysis. While some concepts will overlap, our discussion will move through the stages outlined above and so describe that which emerged in applying the various facets of the framework individually. Throughout, images will accompany the text in order that the statements may be rendered accessible.

Let us begin then by discussing the levels of decomposition that were applied.

6.3.1.1 *The Levels of Decomposition Applied*

Following Engelhardt's recursive approach to syntactic decomposition (2002:13; see Section 2.1.5) two levels of decomposition were seen to be sufficient in order to access the interface's *elementary* graphic objects. On the first level, the interface was seen as a composite graphic object containing a graphic space (i.e. the screen area) and several graphic sub-objects (e.g. other composite graphic objects). On the second level, a number of these graphic sub-objects were seen to contain other graphic sub-objects (i.e. elementary graphic objects, taking the form of pictorial representations, abstract shapes and text).

From the above identification of levels and the graphic objects contained therein, it was possible to begin to interpret both the graphic objects and the graphic relations in which they were seen to be involved. Here, the first stage of interpretation took place; focus was directed towards identifying object-to-space relations and object-to-object relations.

6.3.1.2 *The Object-to-Space Relations and Object-to-Object Relations of the Prototype Interface*

Object-to-space and object-to-object relations are based on the *anchoring* of objects, either to a *spatial position* within the graphic space or to other graphic objects (Engelhardt 2002:55).

Looking first at the interface's object-to-space relations, it was identified that we are dealing with a graphic representation that applies a specific form of *distorted metric space*, which Engelhardt terms a *distorted integral metric space*. While the full implications of this assertion will be discussed in due course, for now we may say that a distorted integral metric space is a graphic space which, in expressing information, offers 'relations of *physical order*, and *distorted physical distance* and *direction* between elements' (p.71, italics in original). Here, in terms of order, we find that the graphic objects are positioned according to the logic of arranging what is 'near' toward the centre of the graphic space and what is 'far' toward its outer edge. Further, all objects are arranged according to the direction at which locations can be found in relation to one-another from the specific sites at which the representation is viewed. (A discussion of the interface's approach to the representation of distance will be offered later, when we look at *types of correspondence*; see Section 6.3.1.3).

The blue lines in the below figure highlight the ‘paths’ along which order and direction are expressed.

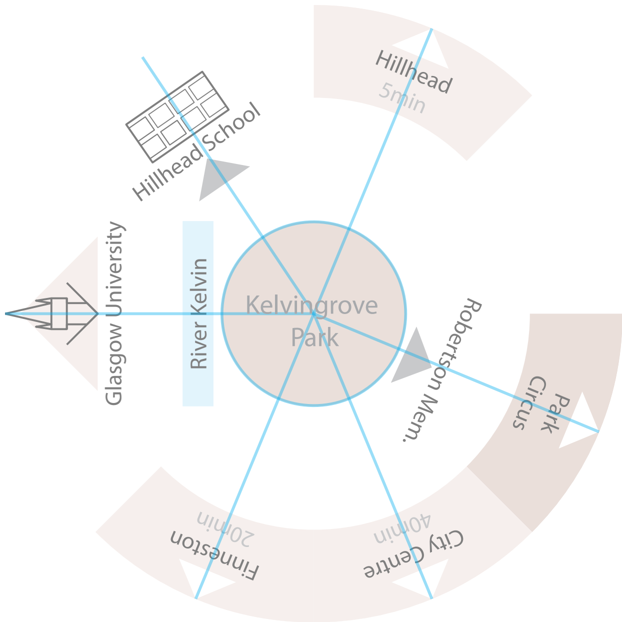


Fig. 6.11 The interface applies a distorted integral metric space, wherein the direction and order of the landmarks, the districts and the river are offered.

From the above, we now turn to consider object-to-object relations. Here, instances of ‘lineup’, ‘containment’ and the ‘spatial clustering’ of graphic objects were all observed. With lineup, graphic objects are seen to be arranged in a linear string both around the interface’s edge and its centre. This is highlighted by the blue circles in figure 6.12 below.

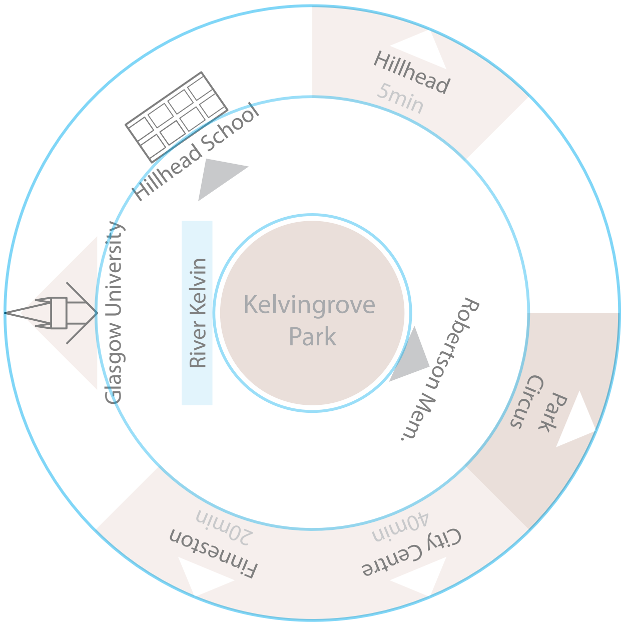


Fig. 6.12 An example of a 'line-up' of graphic objects around the other edge of the graphic space, as well as around the centre.

Next, containment was perhaps most obvious when the composite graphic objects indicating the direction of 'districts' are shown. Here, abstract shapes (i.e. triangles) and text are seen to be 'bound' within arced 'wedge' shapes, as highlighted in figure 6.13 below, where the objects representing districts are emphasised.

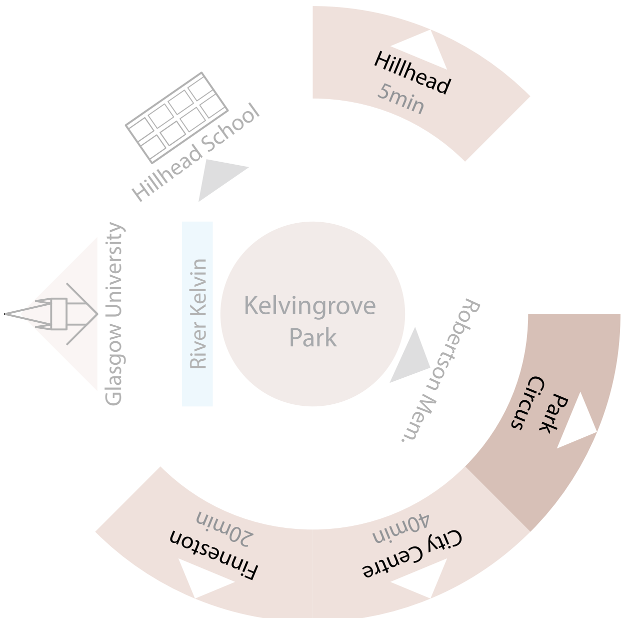


Fig. 6.13 The 'containment' of graphic objects within other graphic objects. Here, we see the district shapes are highlighted. Attention is drawn to how triangles and text are contained within the shapes.

Other instances of containment may also be identified, as in figure 6.14 below, where a triangle *containing* a pictorial representation of a landmark has been isolated for the sake of emphasis.

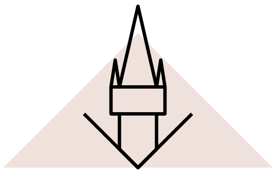


Fig. 6.14 An isolated example of a pictorial representation of a landmark contained within a large triangle.

Another instance of containment may also be observed at the centre of the interface, where an abstract shape (i.e. a circle) is seen to contain text, as is highlighted in figure 6.15 below.

Fig. 6.15 Text is seen to be contained by the abstract shape at the centre of the interface.

Finally, with regard to object-to-object relations, instances of spatial clustering, i.e. the *grouping* of graphic objects, was observed at a number of points. Clustering was particularly evident where text appears next to pictorial objects and/or abstract shapes, as shown in figures 6.16 and 6.17 below.

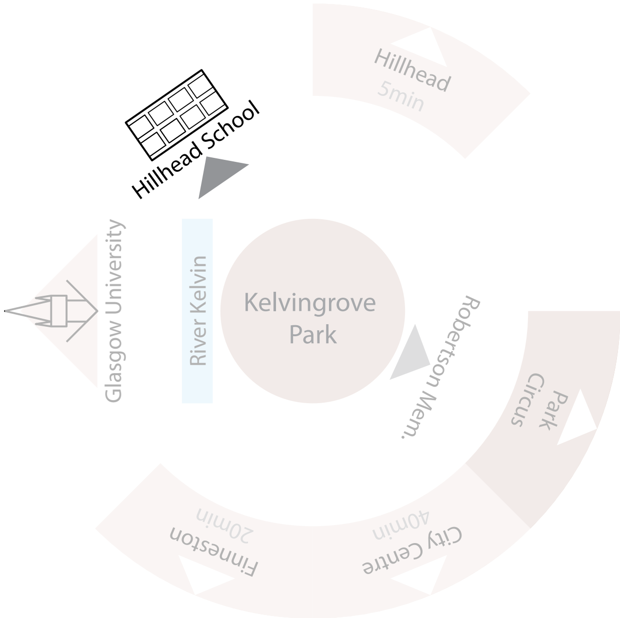


Fig. 6.16 An example of 'spatial clustering' where text and shapes are seen to sit next to a pictorial representation of a landmark.

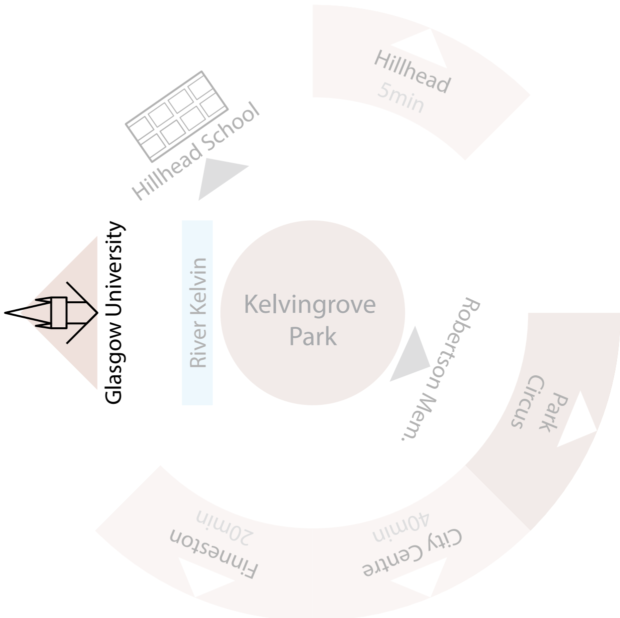


Fig. 6.17 An example of 'spatial clustering' where text is seen to sit next to a composite graphic object, based on an abstract shape, containing a pictorial representation of a landmark.

At a broader level, it must be noted that a further instance of spatial clustering is observed in the interface, where the composite graphic objects at the periphery and near the centre may be seen as being *spatially clustered* around the composite graphic object at the centre (i.e. the abstract shape containing the text).

From the above, with regard to attribute-based object-to-object relations, only a *limited* analysis was undertaken. There are a number of reasons for this. First, what Engelhardt terms area fill attributes (i.e. colour and texture) are not seen as relevant, as these attributes demonstrate little variation across the design. Second, one of the spatial attributes—orientation—has been, to a large degree, determined by the *external* order and direction of the locations presented and, so, is seen as exempt from consideration at present. Third, variation in another spatial attribute—shape—is in some cases determined by the form of external features, i.e. some objects act as pictorial representations of landmarks. As such, this is more a matter of *modes of expression* than a dimension within attribute-based relations and, accordingly, is not seen as relevant to the present discussion.

We are left, then, with a single spatial attribute of *size*. Significant use of variations in size may be observed throughout the interface.

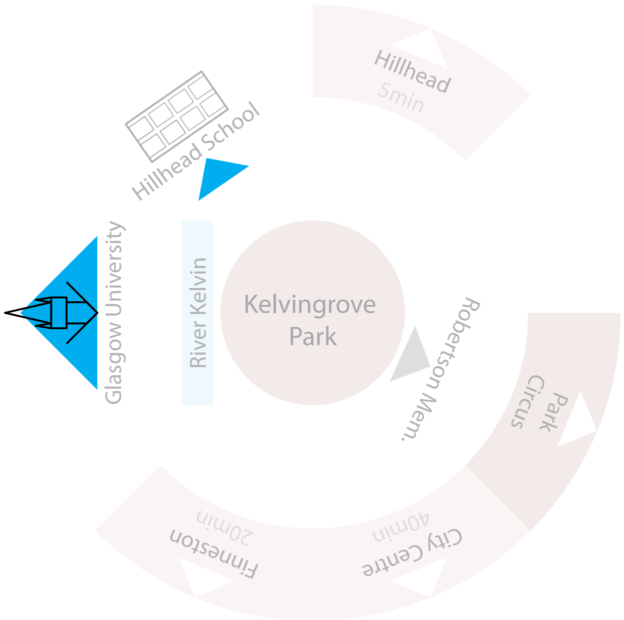


Fig. 6.18 The highlighted triangles demonstrate a significant variation in size from the perspective of object-to-object relations.

Perhaps most significant of all is the variation in the size of a particular variety of *abstract shapes*. Here, large and small triangles were identified, as is highlighted in figure 6.18 above.

Thus we have identified the prominent graphic relations that are seen to have emerged within the interface, as well as highlighted a significant attribute-based variation therein. Let us now move on to identify the major *syntactic roles* (see Section 2.1.5.1.1) that may be discerned within these graphic relations.

6.3.1.2 *Identifying Syntactic Roles*

The syntactic roles of graphic objects are seen to result from their *anchoring* within the syntactic structure (Engelhardt 2002:74). Here, a graphic object may be 'anchored' either to a meaningful position in graphic space and/or to another graphic object. Thus, we may identify object-to-space anchorings and object-to-object anchorings.

We begin by identifying what is perhaps the most prominent example of object-to-object anchoring in the interface. Here, arising out of the spatial clustering of objects, we may observe examples of the syntactic role of *labelling* throughout the interface. That is, we may observe instances where text, pictorial representations or abstract shapes are spatially clustered with or contained in other graphic objects (Engelhardt 2002:34). Examples of text labelling are highlighted in figure 6.19 below.

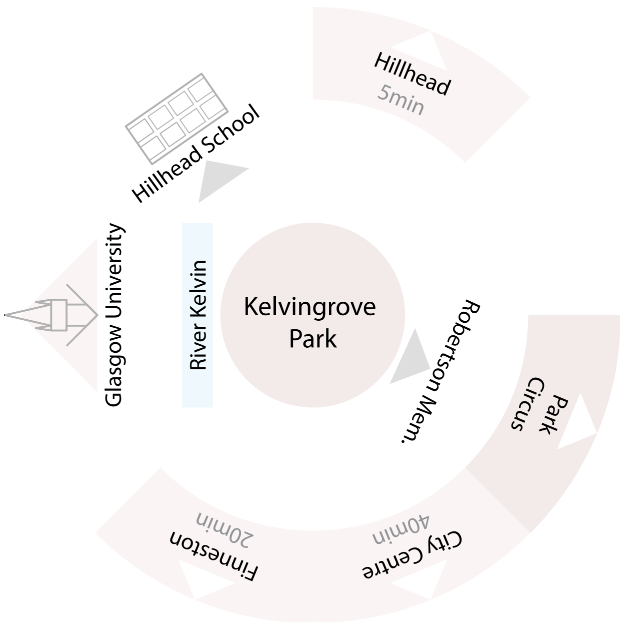


Fig. 6.19 An example of 'labelling'. Here we see that a number of graphic objects are identified by text (highlighted).

Further to this, we may see examples of abstract shapes (i.e. triangles) labelling pictorial representations of landmarks and other abstract shapes, as highlighted in figure 6.20 below.

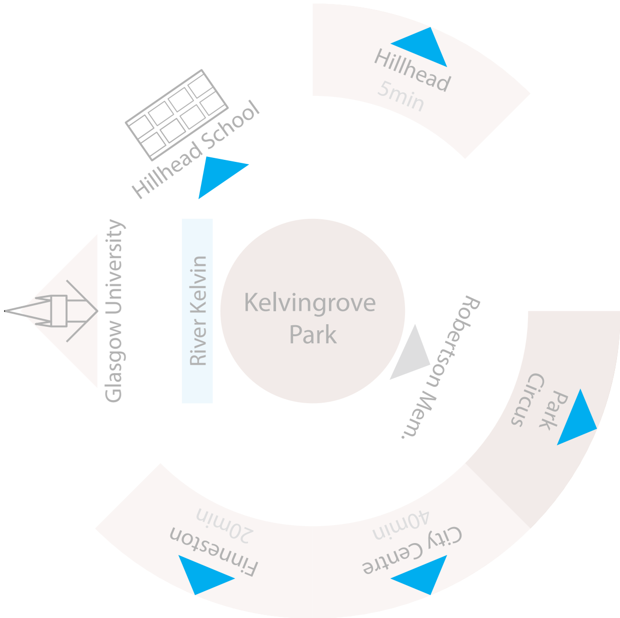


Fig. 6.20 An example of 'labelling'. Here we see that a number of abstract shapes (i.e. the arced wedges) and a pictorial representation of a landmark are labelled with other abstract shapes, i.e. triangles (highlighted).

From this, we turn to a prominent object-to-space anchoring. Here, firstly, at the centre of the interface, a composite graphic object may be observed: a circle in the centre, which contains text. This object displays the user's location and is shown in the below figure.

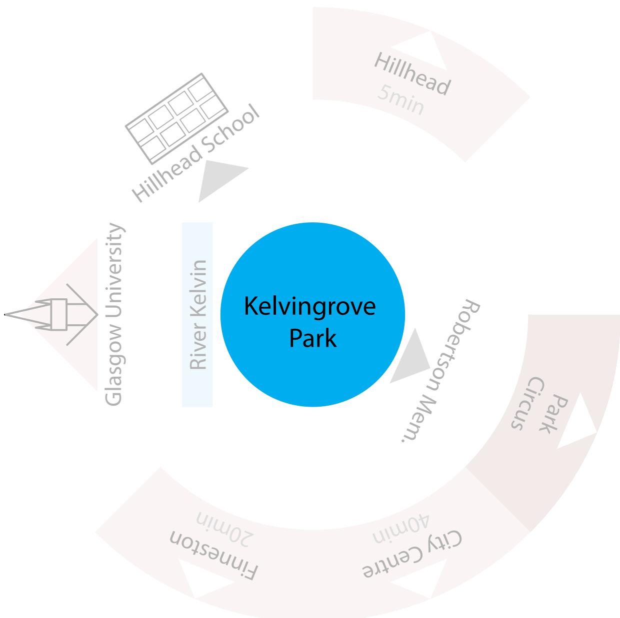


Fig. 6.21 The circle showing the user's location on the interface.

In interpretation, some thought has been given to the specific role played by this object. On the one hand it appears to be anchored in meaningful space, distorted though that space is. Additionally, in terms of the exactness of its spatial positioning it is fixed, i.e. its position in the graphic space does not alter even when the user changes location. As such, it would seem that it is a *point locator* (Engelhardt 2002:76). However, such a designation was viewed as unsatisfactory on the basis that *other* graphic objects do *not* hold fixed positions, rather they rotate around it. (We will deal with the dynamic aspects of the representation in Section 6.3.2 below). As a result it would seem that this graphic object is not anchored in graphic space at all, but rather in a complex series of object-to-object relations.

Accordingly, by way of an alternative, the syntactic role of *node* was chosen on the basis that such a designation is deemed appropriate when other roles do not apply (ibid:196). To flesh the role out further we may say that this node displays the user's location.

Leading directly on from the above, we may look to the graphic objects with which this centre node may to be seen to hold relations. Specifically, looking around the centre and peripheral lineups we may identify a series of composite and elementary graphic objects, which are *clustered* around the position of the centre node (as was identified in Section 6.3.1.2 above). An example of such anchoring is highlighted below in figure 6.22.

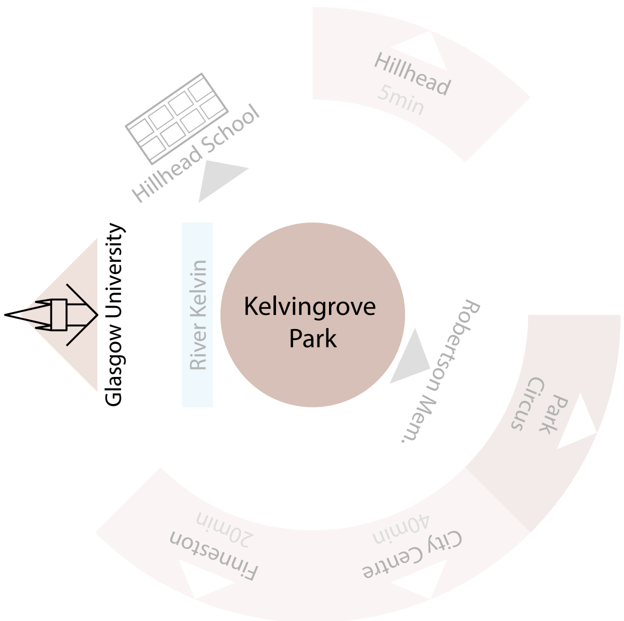


Fig. 6.22 The above highlighted composite graphic objects are, when considered together, seen to express to a direction.

Once the clustering of these objects was identified, an attempt was made to define any object-to-space relations the objects might have. While they were seen to rotate and, so, were not fixed in the graphic space, they *did* maintain a relationship with the position of the centre node. As, such they were seen as anchored to this position. Thus, as before, these objects were interpreted as *nodes*, which in their anchoring with the position of the centre node were seen to express information relating to *direction*.

To flesh out this notion, let us consider two other examples. In figure 6.23 below, we see a composite graphic object in relation with the centre node and, in this, expressing information relating to the direction of a district.

Fig. 6.23 The above highlighted composite graphic objects are, together, seen to express information relating to the direction of a district.

Then, in figure 6.24 below, we see another composite graphic object in relation with the centre node and, in this, expressing information relating to the direction of a river.

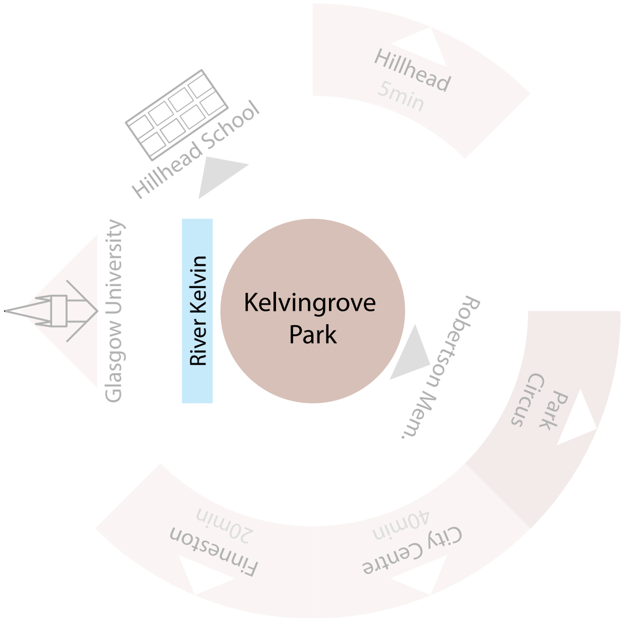


Fig. 6.24 The above highlighted composite graphic objects are, when considered together, seen to express information relating to a direction, in this case the direction of a river.

We have thereby identified and discussed what are held to the key syntactic roles within the interface. From this, we will briefly turn our attention to consider the interpretation of the graphic representation.

6.3.1.3 *Interpreting the Graphic Representation: The Types of Correspondence and Modes of Expression*

In the interpretation of a graphic representation, Engelhardt proposes that focus be directed towards its types of correspondence (i.e. the relationship between what is shown and what is meant; see Section 2.1.5.2). Additionally, for our present purposes it will also be useful to briefly give dedicated consideration to the modes of expression found in the representation, as this will allow us to distinguish whether an object is pictorial or non-pictorial.

We begin then with types of correspondence. As was set out in Section 2.1.5.2, correspondence is seen to occur at the level of the spatial structure, the elementary graphic objects, and the visual attributes displayed by graphic objects. In all cases, correspondence may be literal, metaphoric or arbitrary-conventional.

If we look first to the correspondence of the spatial structure, it will be helpful to recall that earlier, in Section 6.3.1.2, the graphic space was defined as a *distorted integral metric space*. Here, it was noted that distorted integral metric spaces offer the *physical order* and *direction* of the elements but a *distorted physical* distance (Engelhardt 2002:71). As was outlined in Section 6.2.1, order is dealt with in a system, in which represented sites are arranged based on whether they are here, near here or far. This system doubles up as an approach to expressing relations of physical distance in abstract terms (i.e. distance is also defined according whether a site is here, near here or far). Accordingly, one might argue that representing a physical structure in this way might be considered *metaphoric*. Such a framing would lead to the designation of the spatial structure as *hybrid*, i.e. representing a *combined* literal and metaphoric structure (Engelhardt 2002:103-104; see Section 2.1.5.2). On reflection, however, the view was taken that this systematic manipulation amounts to a manipulation of literal distance as opposed to a representation involving metaphoric correspondence to literal distance. As Engelhardt points out, technically all representations of physical structures involve at least subtle distortion (2002:67). Consequently, it was decided that the order and direction of the landmarks, the districts and the river involves a *literal* correspondence, while their positioning was seen to involve a *distorted literal correspondence*. In this, a parallel is drawn with Engelhardt's own interpretation of the Tube map (see Section 6.1.3.4 below and Engelhardt 2002:67).

Moving on to the elementary graphic objects, a number of graphic objects were found to involve a literal correspondence, i.e. resemble the physical structure they represent. For example, the Hillhead school bares resemblance to the physical school building. Beyond this, other landmarks were found to be involved in arbitrary-conventional correspondence, i.e. they are represented by simple triangles. Equally, the district nodes were also seen to be involved in an arbitrary-conventional correspondence. This particular arbitrary-convention was judged to be internal to the representation. That is, the application of wedge shapes in the representation of districts was seen as particular to the visual language of the interface.

Next, with the visual attributes, focus was directed towards colour as, apart from shape (which is dealt with above), this attribute was seen to be the most relevant in the representation of the physical structures. Here, again, examples of both literal and arbitrary correspondence were identified. The blue of river was viewed as being involved in literal correspondence, while the colours assigned to the district nodes and landmark nodes were judged to be arbitrary, in that they did not faithfully resemble the colour of these sites, at least not in an accurate sense.

From the above, we turn lastly to modes of expression. Here the interface was seen to contain several semi-realistic pictorial graphic objects (i.e. the landmarks) and many non-pictorial objects. The latter include: abstract shapes for the districts, the river and some landmarks; text providing the names of various sites; and numbers stating the walking-times to particular sites.

We have thereby discussed the interpretation of the graphic representation from the perspective of its types of correspondence, and its modes of expression. We will now move to finally classify the interface as a *type* of graphic representation.

6.3.1.4 *Classifying the Graphic Representation*

In seeking to identify the type of graphic representation presented by the interface, we may connect with Engelhardt's own system of classification (see Section 2.1.5.3). Within this system classifications are designated based on the type of syntactic structure involved in the graphic representation as well as the type of information presented. As was noted in the literature review, Engelhardt proposes that graphic representations may be separated into one of two categories: primary types (e.g. maps, pictures, statistical charts, and time charts) and hybrid types. As no alignment could be drawn with the primary types the view was taken that the interface may be seen as a *hybrid type* of graphic representation.

Engelhardt proposes the following list of six hybrid types: 'statistical map, path map, statistical path map, statistical time chart, statistical link diagram, and chronological link diagram' (2002:137). None of these hybrid types could be said to properly classify the graphic representation presented by the interface. Thus, it was necessary to infer a novel type from other classifications made in Engelhardt's thesis, so as a 'fit' might be made with the overall system.

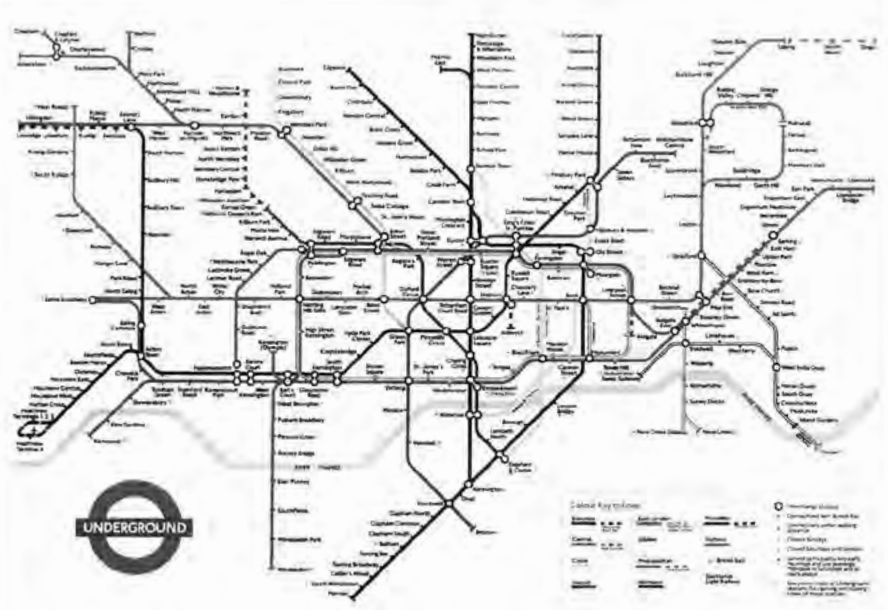


FIGURE 2-32: London Underground diagram. SOURCE: London Transport.

COMMENT: This figure serves to illustrate a *distorted integral metric space*. A part of this subway map was shown earlier (as figure 2-15) to illustrate *linking* by *connectors*.

SYNTAX OF SPATIAL STRUCTURE (2.5): A *distorted integral metric space* with *line locators* that are also *connectors* between *labeled nodes*. There are two *insets* (a logo and a legend). An additional *line locator* (representing the river Thames) is displayed, which is not part of the *connector*-network.

TYPE OF CORRESPONDENCE (3.1): SPATIAL STRUCTURE: The *linking* of the stations involves *literal* correspondence, while their positioning involves *distorted literal* correspondence. VISUAL ATTRIBUTES: The *colors* of the lines involve *arbitrary-conventional* correspondence.

TYPE OF GRAPHIC REPRESENTATION (4): A *path map* (= both a *map* and a *link diagram*).

Fig. 6.25 Engelhardt (2002:67) classifies the Tube map as a path map.

Here, we turn to Engelhardt's analysis of the Tube map, which he classifies as a 'path map'. This classification is based on the fact that, from Engelhardt's perspective, this representation is seen to combine a *map* with a *link* diagram. We must infer that the inclusion of the term 'path' arises from the type of information that the link diagram is seen to present (i.e. the *path* of Tube lines).

Taking heed of the above, an effort was made to classify the interface by considering its information and syntactic structure. In terms of information, as has already been noted in regard to object-to-space relations, it is seen to express the direction and order of physical geographic *locations*. Accordingly it would appear reasonable to posit that in terms of the overall, the type of information being expressed relates to *orientation*. Leading on from this, in terms of a type of syntactic structure, the interface is seen to offer a distorted integral metric space, like the Tube map above. Thus, it seems reasonable to infer that the interface is a type of map. Therefore, by integrating the above, we may tentatively classify our novel hybrid type of graphic representation as an *orientation map*.

This ends our graphic syntax analysis. The results of the analysis are listed below. Here we take the same approach as recommended by Engelhardt (2002:151-152), whereby an outline of the syntax of the spatial structure, is followed by an overview of the type of correspondence, which in turn is followed by a classification of the type of graphic representation.

Syntax of the Spatial Structure: A *distorted integral metric space* with multiple *labelled nodes* (representing landmarks, districts and a river), which in turn are clustered around a central *labelled node* (representing the user's location).

Type of Correspondence: Spatial structure: The order and direction of the landmarks, the districts and the river involves literal correspondence, while their positioning involves *distorted literal* correspondence. Elementary graphic objects: Literal pictorial representation is applied at times for the representation of landmarks. Additionally, non-pictorial arbitrary abstract shapes and text are also applied for landmarks. For districts and the river arbitrary abstract spaces are applied.

Visual attributes: The colours of some nodes involve literal correspondence (e.g. blue for the river), while the colours of others involve arbitrary correspondence (e.g. orange for the districts).

Type of Graphic Representation: An orientation map.

Having completed the above analysis, we will now move on to consider the application of Engelhardt's theory in relation to the dynamic and interactive aspects of the interface, as was originally proposed in Section 2.1.5.4.

6.3.2 *The Second Major Contribution: An Extension of Engelhardt's Graphic Syntax Framework to Allow for the Incorporation of the Dynamic and the Interactive*

As was originally stated in Section 2.1.5.4 in the literature review, Engelhardt makes clear that his thesis presents an overview of the general principles of the visual language of *static* rather than *dynamic* or interactive graphic representation, but notes that most of his concepts remain applicable in this domain (2002:10).

Having highlighted the above, it was proposed that in applying Engelhardt's framework in this enquiry, the theory's concepts might be trialled in relation to the dynamic and interactive aspects of our graphic representation such that their applicability and possible adaption or extension might be considered. Accordingly, now that we have applied the theory's framework in an analysis of the prototype, we will here move to identify any additional concepts that might need to be integrated within the theory, such that it may be rendered applicable to dynamic and interactive graphic representation.

In graphic syntax analysis, three difficulties arose in seeking to attend to the prototype's dynamic and interactive features (see Section 5.4.1 for an outline of these). Firstly and perhaps most obviously, as Engelhardt assumes the graphic representations being analysed shall be static and not interactive, it was not possible to account for the refreshing of the representation. Secondly, for the same reason, it was difficult to account for the dynamic rotation of the graphic objects in relation to one another. (Though it is clear enough that, in their rotation these objects are involved in a literal correspondence with the physical structures they represent). Thirdly, and lastly, it was also difficult to account for the notion that in order for these dynamic and interactive features to occur, a user, i.e. a person, must *interact* with the interface across space and in time.

Thus, from the above, it would seem that additional concepts are required which would allow for: transformation of the representation; dynamic graphic objects; and the context-based interactions of an independent user within particular spatiotemporal episodes.

Having identified the above, we will now look at how such additional concepts might be framed with reference to the existing theory, as well as a number of other perspectives drawn from relevant sources.

6.3.2.1 *An Additional Analytic Level: Accounting for the Dynamic and Interactive*

At this point, it will be helpful to here re-present the diagrammatic overview of Engelhardt's theory that was first presented in Section 2.1.5.3 of the literature review.

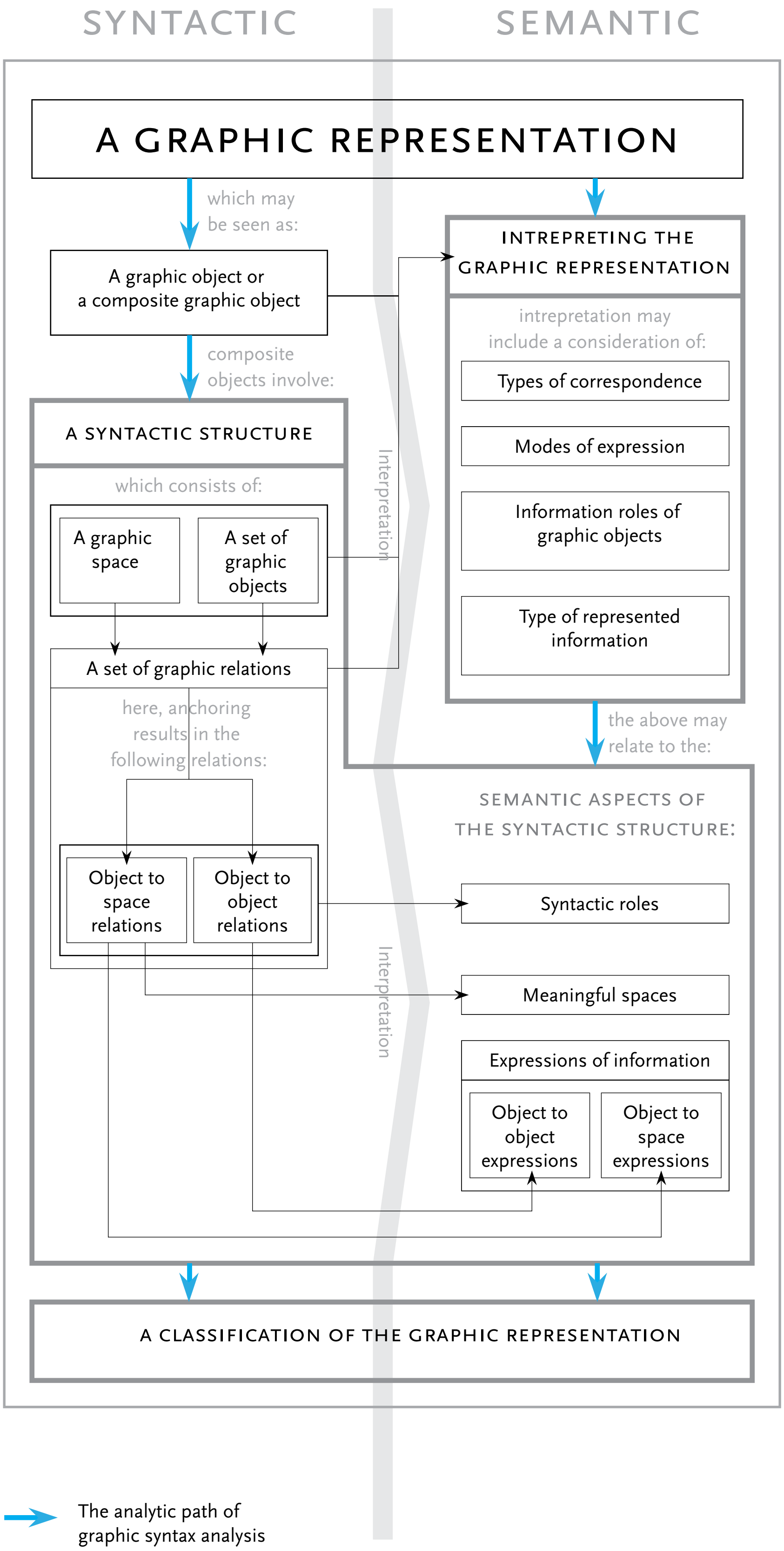


Fig. 6.26 Engelhardt's graphic syntax theory as portrayed in the present enquiry.

With reference to the above, it will be recalled that Engelhardt's framework places emphasis on the syntactic and the semantic. The former, i.e. syntactics, relates to the *recursive* decomposition of graphic objects. This aspect of the framework is set out along the left hand side of the diagram. The latter, i.e. semantics, relates to the *interpretation* of the syntactic structure which is seen to emerge in decomposition (2002:13). This aspect is set out along the right hand side of the diagram.

Reviewing this dual approach, it would seem that in order to enfold the concepts of transformation, dynamic graphic relations and context-based spatiotemporal user interactions an additional level of analysis is required; one which might account for all three.

Turning to the literature, we find that Engelhardt has already considered the potential for such a level. In a book chapter written with Alan Blackwell prior to the finalisation of *The Language of Graphics*, the pair present a 'meta-taxonomy' for diagram research (Blackwell and Engelhardt 2002). Herein, through analysis of pre-existing taxonomies, a set of what are termed 'taxonomic aspects' are offered. These are listed as follows:

'*Signs* or components of a diagram:

1. Basic graphic vocabulary
2. Types of tokens
3. Pictorial abstraction

Graphic structure of a diagram

4. Graphic structure

Meaning of the diagram

5. Mode of correspondence
6. The represented information

Context related aspects

7. Task and interaction.
8. Cognitive processes
9. Social context'

(Blackwell and Engelhardt 2002:48, italics in original)

Above, we see many of the concepts presented in *The Language of Graphics* (Engelhardt 2002) in evidence. For example, the 'basic graphic vocabulary' aspect is analogous to Engelhardt's own notion of 'graphic objects'. While, 'graphic structure' is analogous to his 'graphic relations' (see Section 2.1.5). Beyond these familiar aspects, we find three *additional* 'context related aspects' appended at the end of the list, i.e. task and interaction, cognitive processes and social context. It is with these aspects, i.e. the context-related, that Blackwell and Engelhardt claim the outstanding research issues lie. Interestingly, they also ask whether the neglect of this area is 'desirable or necessary' (Blackwell and Engelhardt 2002:60).

Providing an overview of the relationship between each of the context-related aspects, the pair present a dedicated diagrammatic overview, which is reproduced below in figure 6.27.

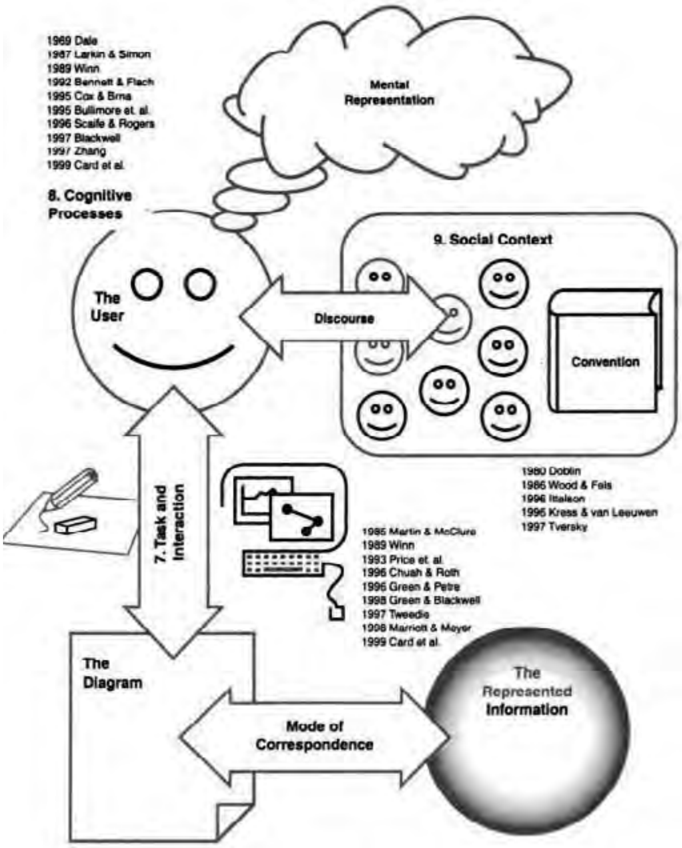


Fig 6.27 Blackwell and Engelhardt's contextual taxonomic aspects in diagram research (Blackwell and Engelhardt 2012:49).

Above, we see that the user is, to a certain extent, centralised and related to the various context-based aspects just mentioned.

Below the user, we find 'the diagram' (i.e. a graphic representation). Then, connecting the user to the diagram, we see the aspect of task and interaction. Blackwell and Engelhardt define task and interaction as 'the activity of a person interacting with the diagram, the structure of the task, and the tools that are used to complete the task' (ibid:52).

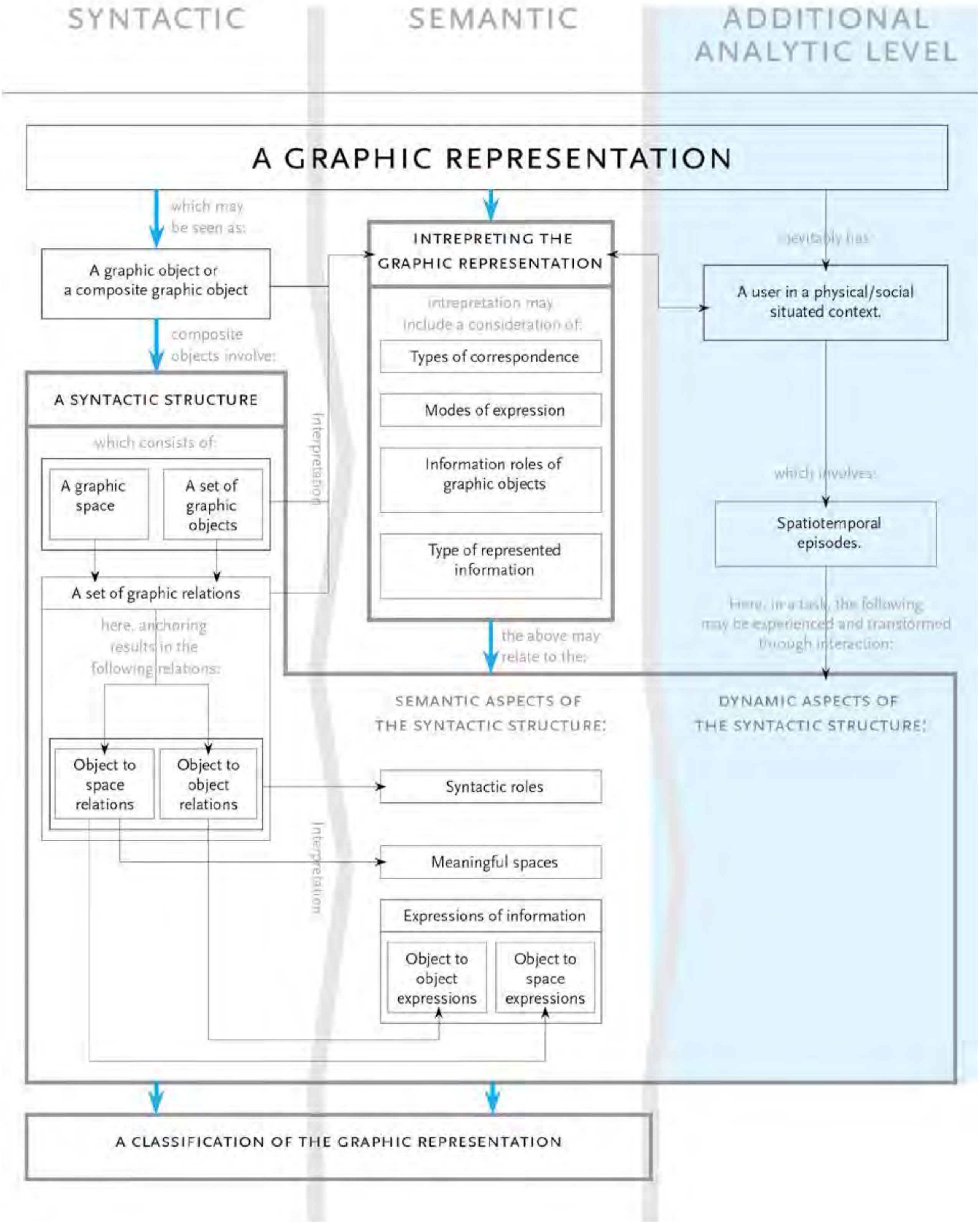
Grouping these together, if we replace 'diagrams' with 'graphic representations', we are able to account for the interactions of an independent user. Further, as a user must be situated in space as well as time we may also account for the notion of their being involved in a particular physical context, which in turn allows us to account for spatiotemporal episodes; and it is within these spatiotemporal episodes that task and interaction occur.

Thus, from the above, as a first step to developing a new analytic level within graphic syntax, we may now include a user in a physical context, spatiotemporal episodes, as well as a task and interaction as *additional* concepts.

Beyond the above, we see that the aspects of social context and cognitive processes are also enfolded within Blackwell and Engelhardt's diagrammatic overview. The social context is linked to the user via the notion of 'discourse', while the cognitive processes are seen as inherent to the user, i.e. they are not linked but rather embedded within the pictorial representation of the user.

These aspects are not as easily enfolded in the new analytic level as those which have been incorporated above. This is due to the fact that neither is seen to enable discussion relating to the dynamic or interactive features of graphic representations; rather, the view is taken that their inclusion would contribute to the *framing* of discussion relating to these areas. That said, it seems fair and indeed sensible that the aspect of social context be incorporated as a dimension within the pre-established concept of physical context. With regard to cognitive processes, it will be recalled that within this enquiry the decision has been taken to eschew discussion of cognitive processes in isolation (e.g. memory) and instead focus on the study of the viewer's/user's holistic *experience* of a graphic presentation (see Section 2.1.2). As such, in keeping with the perspective applied thus far, we shall sideline the aspect of cognitive processes for the time being. (By way of an alternative, we will move to incorporate the user's understandings in Section 6.4.1 as we seek to contextualise the graphic syntax).

Having considered and selected context-based aspects from Blackwell and Engelhardt's meta-taxonomy for inclusion in within an additional level in graphic syntax analysis, we are now in position to present a diagrammatic overview of the proposed extension as it stands in figure 6.28.



The proposed theoretical extension

A specfic connection

The analytic path of graphic syntax analysis

Fig 6.28 An additional analytic level is proposed. Herein, the additional concepts of a user in a physical/social context, spatiotemporal episodes and task and interaction are proposed.

Surveying the above and recalling the three difficulties that arose in seeking to attend to the dynamic and interactive features of the prototype, it will be noted that we are now able to account for the interactions of an independent user. However, it will also be noted that while the syntactic structure has been expanded into the additional analytic level (i.e. been included within it), it is not yet possible to explicitly deal with either the transformation of the representation or dynamic graphic objects.

In order to find a way of doing so, we will reformulate and progress the concepts currently presented at the static semantic level into our new analytic level such that each is seen to gain a *dynamic* quality. Such a progression implies that the graphic objects and/or graphic spaces would change *over* time, resulting in dynamic graphic relations. The notion of dynamic graphic relations, in turn, allows us to propose the concepts of: dynamic syntactic roles, dynamic meaningful spaces and dynamic expressions of information. In order to offer a definition of each of these concepts we will now refer to Engelhardt's original definition of static syntactic roles, meaningful spaces and expressions of information.

Here, we find the following definition of a syntactic role:

> 'A syntactic role is a role that a graphic object may play in the syntactic structure.'
> (Engelhardt 2002:197)

Then, meaningful spaces are defined as:

> 'The graphic space of a composite graphic object is meaningful if the spatial positions in it are subject to interpretation regardless of whether or not there are graphic sub-objects present at those positions.'
> (ibid:54)

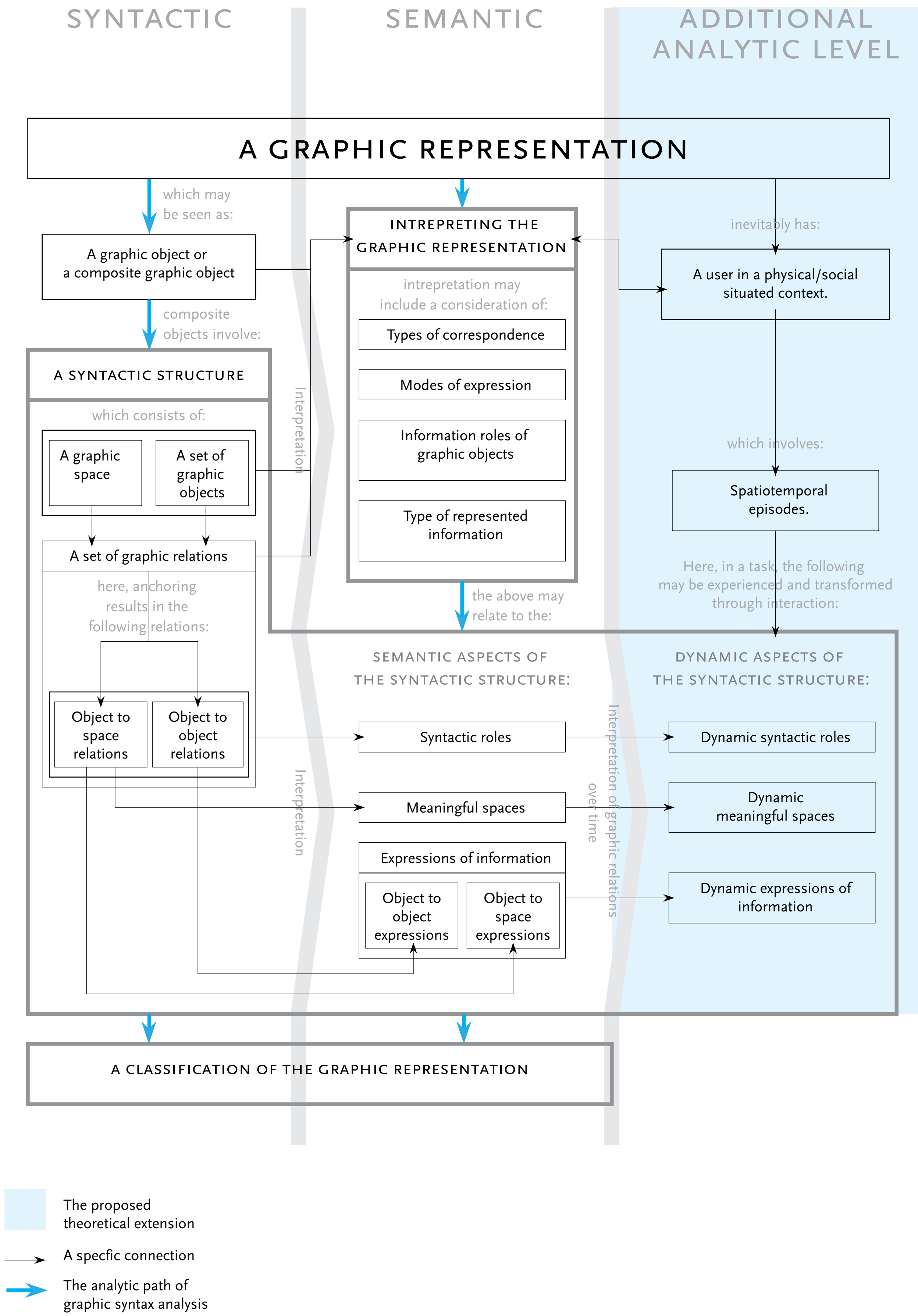
Lastly, the notion of the expression of information is not formally defined but rather arises out of a discussion of object-to-object relations and object-to-space relations (p.55). Here, Engelhardt simply sets out the types of information that object-to-object relations and object-to-space relations may express.

From the above, we may now propose the following definitions for the dynamic reformulation of syntactic roles, meaningful spaces and expressions of information:

- A dynamic syntactic role would refer to the role a moving/transforming graphic object plays within a dynamic syntactic structure over time.
- A dynamic meaningful space would refer to a graphic space in which spatial positions become/remain subject to interpretation regardless of whether or not there are graphic sub-objects present at those positions as the space moves/transforms over time.
- A dynamic expression of information would refer to the type of information, which dynamic graphic relations (i.e. either object-to-object relations or object-to-space relations) are seen to express over time.

These reformulated concepts are now incorporated in an adaption of the previous diagram, presented in figure 6.29 below.

Fig 6.29 The proposed additional analytic level is extended through a reformulation and progression of the semantic aspects of the syntactic structure. Here, the concepts of dynamic syntactic roles, dynamic meaningful spaces and dynamic expressions of information are included.



SYNTACTIC
SEMANTIC
ADDITIONAL ANALYTIC LEVEL
A GRAPHIC REPRESENTATION
which may be seen as:
A graphic object or a composite graphic object
composite objects involve:
A SYNTACTIC STRUCTURE
which consists of:
A graphic space
A set of graphic objects
A set of graphic relations
here, anchoring results in the following relations:
Object to space relations
Object to object relations
INTREPRETING THE GRAPHIC REPRESENTATION
intrepretation may include a consideration of:
Types of correspondence
Modes of expression
Information roles of graphic objects
Type of represented information
the above may relate to the:
inevitably has:
A user in a physical/social situated context.
which involves:
Spatiotemporal episodes.
Here, in a task, the following may be experienced and transformed through interaction:
Interpretation
SEMANTIC ASPECTS OF THE SYNTACTIC STRUCTURE:
DYNAMIC ASPECTS OF THE SYNTACTIC STRUCTURE:
Syntactic roles
Meaningful spaces
Expressions of information
Object to object expressions
Object to space expressions
Interpretation of graphic relations over time
Dynamic syntactic roles
Dynamic meaningful spaces
Dynamic expressions of information
A CLASSIFICATION OF THE GRAPHIC REPRESENTATION
The proposed theoretical extension
A specfic connection
The analytic path of graphic syntax analysis

Of course, these newly reformulated and progressed concepts are not an end in themselves. We still require a means by which dynamic syntactic roles, dynamic meaningful spaces and dynamic expressions of information may be described. In order to enable such description, a system for discussing spatiotemporal changes in a graphic representation is now sought.

6.3.2.2 Describing the Spatiotemporal Changes: A Means by which Dynamic Graphic Relations may be Grounded

Reviewing the literature concerning the description of spatiotemporal change in graphic representations an array of competing and sometimes divergent perspectives are revealed. Commencing the discussion in *The Semiology of Graphics* (see Section 2.1.3), Bertin pointedly *excluded* 'actual movement' as an aspect of his theory. This exclusion was made on the grounds that any consideration of 'cinematographic expression very quickly reveals that most of its laws are substantially different from the laws of atemporal drawing'. He goes on to state that although movement introduces 'only one additional variable, it is an overwhelming one' (2011/1967:42).

Since Bertin, several proposals have been put forward which begin to offer possible framings of *spatiotemporal* change within graphic representations. Some of these framings focus on the *temporal* aspects of change (i.e. offer time-based framings), while others focus on the *spatial* aspects of change (i.e. offer framings focusing on the changes which occur to graphic objects in graphic space). Many of the temporally-focused framings are presented as a set of variables, which may be appended *directly* to pre-existing work on *static* graphic variables (i.e. Bertin's visual variables; see Section 2.1.3). In such cases, the variables are often termed *dynamic* variables (e.g. MacEachren 1995). We will look first at these temporally-focused proposals.

One of the earliest such proposals comes from Magnetat-Thalman and Thalman (1990). The pair suggest that, in the context of animation, graphic objects may be redefined as *animation objects*. These *animation* objects, in turn, are said to be in a *scene* (i.e. positioned in an image) and have a *sequence* (i.e. an order in which events occur).

This contribution was soon followed by the work of Dibase et al. (1992) who, in considering 'map design', proposed a set of three dynamic visual variables: *duration*, *rate of change* and *order*. From this, a number of other theorists have proposed similar but distinct sets of dynamic visual variables. Shepard (1994) suggests the variables of *timing* (i.e. when something happens), *motion/position of change* and *blinking*. While Wilkinson (2005/1999) suggests the variables of *motion direction*, *motion speed*, and *motion acceleration*.

Beyond these, seeking to extend Dibase et al.'s work, MacEachren (1994) proposed that three additional variables be appended to Dibase et al.'s original set: *display date*, *frequency* and *synchronisation*. This extension represents the most wide-ranging set of dynamic variables yet proposed. From MacEachren (1995) we may define scope of each as follows:

- Display date refers exclusively to the time a display change is initiated (p.281);
- Duration refers to the 'length of time between two identifiable states' (p.282);
- Order refers to 'the sequence of frames or scenes' (p.284), i.e. what happens when;
- Rate of change refers to the difference in 'change/unit time for the sequence of frames or scenes' (ibid);
- Frequency refers to the number of states which may be identified within a unit of time (i.e. a set period of time);
- Synchronisation, also entitled 'phase correspondence', refers to the simultaneous presentation of two or more animated sequences of data (ibid).

From these temporally-focused proposals, we will now turn to look at some proposed framings of spatiotemporal change which take a spatial-focus.

Two relevant contributions are identified by individuals working beyond an information design context. The first comes from Esbenbach (1998). In researching abstract dynamic spatial phenomena and its representation, Esbenbach suggested that movement might be classified as being one of two main types. Here, one might observe the movement of an object along a trajectory (i.e. moving through a space) or, alternatively, movement might be seen to take place *within* an object. The second contribution comes from Yattaw (1999). Yattaw took a somewhat different approach to Esbenbach. Focusing on the conceptualisation of geography, she takes the spatial concepts of *point*, *line*, *area* and *volume* and links these to the temporal concepts of *continuous*, *cyclical* and *intermittent* in a matrix. In this way, Yattaw proposes twelve classes of movement over relatively long periods of time.

Despite the obvious potential of these proposals, it is however the work of Hornsby and Egenhofer (1997) which is seen as the most pertinent in the context of the current discussion. Let us now look at their proposal in order that its pertinence may be revealed.

Considering the querying of dynamic information in geographic information systems (GIS), the pair propose a system for classifying 'the sequences of change' which may occur at—what they term—the object level (p.15). Here, a distinction is made between single, lone objects and composite objects (i.e. objects which are seen to contain other objects).

With single objects, the pair propose a number of ways in which they might appear/disappear, combine, as well as split (i.e. separate apart). The below table sets out the main variations along with a definition of each. A figure illustrating the variations of splitting follows the table (figure 6.30).

Changes to Single Objects

Type of Change Described	Specific Change Described	Definition
Ways of Appearing/Disappearing	Create	An object appears.
	Destruct	An object disappears.
Ways of Combining	Merge	Two objects combine to create a new object and thereafter cease to exist.
	Generate	Two objects combine to create a new object and thereafter continue to exist.
	Mix	When a new object is created from two original objects and thereafter one object continues to exist, while the other ceases to exist.
Ways of Splitting	Splinter	When one object splits from another, while the original continues to exist.
	Divide	When two new objects are created from an original, which in turn ceases to exist.

Table 6.2 The types of change which may occur to single objects according to Hornsby and Egenhofer (1997).

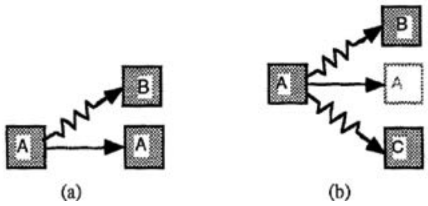


Fig. 6.30 Changes relating to the splitting of single objects: (a) Splintering, when one object splits from another, while the original continues to exist; (b) Dividing, when two new objects are created from an original, which ceases to exist (from Hornsby and Egenhofer 1997:23).

For composite objects, a similar set of proposals are put forward. Here, Hornsby and Egenhofer consider the ways in which such objects may be combined or split. This results in a system of seven possible changes, which may occur to composite objects. These are all set out and defined on the below table. The subsequent figures illustrate each specific variation.

Changes to Composite Objects

Type of Change Described	Specific Change Described	Definition
Ways of Combining	Aggregate	When two single objects combine to create a single composite object.
	Compound	When a composite object and single object combine to create a new composite object.
	Unite	When two composite objects combine to create a new composite object, which preserves all the original composite objects within it.
	Amalgamate	When two composite objects combine not only at the composite object level but also at the single sub-object level, i.e. the sub-objects combine also.
	Combine	When two composite objects combine to create a new composite, which does not preserve the original composite objects within it.
Ways of Splitting	Secede	When one or more single sub-object is seen to split from a composite object.
	Dissolve	When all single sub-objects are seen to split from a composite object.

Table 6.3 The types of change which may occur to composite objects according to Hornsby and Egenhofer (1997).

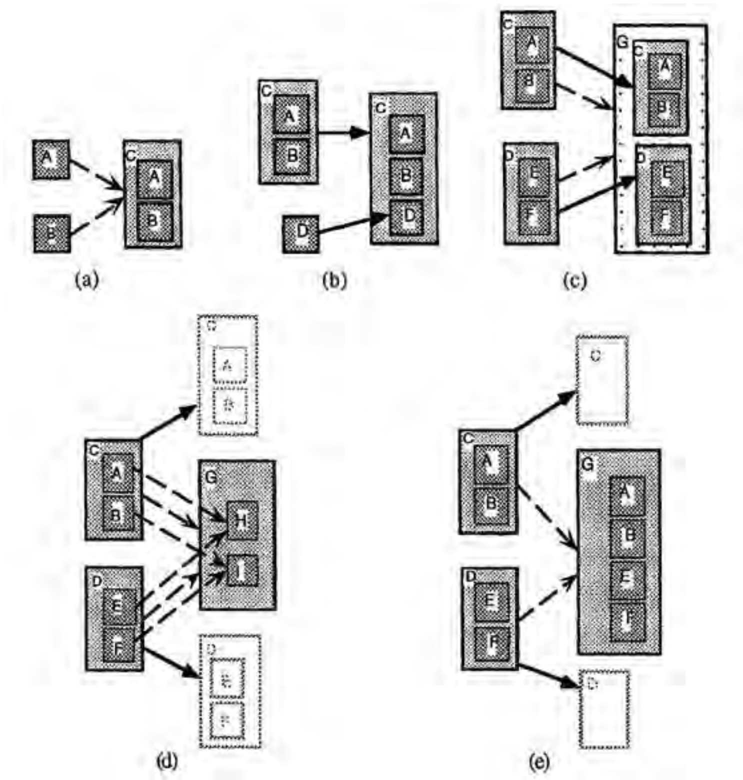


Fig. 6.31 Changes relating to the combining of composite objects: (a) Aggregate, when two single objects combine to create a single composite object; (b) Compound, when a composite object and single object combine to create a new composite object; (c) Unite, when two composite objects combine to create a new composite, which preserves all the original composite objects within it; (d) Amalgamate, when two composite objects combine not only at the composite object level but also at the single sub-object level, i.e. the sub-objects combine also; (e) Amalgamate, when two composite objects combine to create a new composite, which does not preserve the original composite objects within it (from Hornsby and Egenhofer 1997:21).

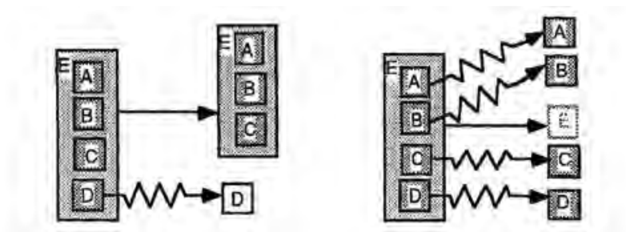


Fig. 6.32 Changes relating to the splitting of composite objects: Secede, on the left, wherein one or more single sub-object is seen to split from a composite object; Dissolve, where all single sub-objects are seen to split from a composite object (from Hornsby and Egenhofer 1997:23).

The above system is seen to provide us with clear, adaptable terms relating to spatial object-based changes. These terms may be easily linked to graphic syntax theory on the basis that an inherent distinction is made between changes which occur to single objects (i.e. elementary objects) and composite objects. Thus, we shall return to it due course.

At this point however, having set out a range of temporally and spatially focused proposals dealing with spatiotemporal change in graphic representations, we will turn to look at a final significant contribution to the field made by Connie Blok (2005). Through work undertaken for her Ph.D. thesis looking at the monitoring of spatial phenomena through interactive cartographic animations, Blok offers a wide-ranging assessment of the scope and potential effectivity of dynamic variables. Crucially, she is careful to give explicit consideration to both spatial and temporal change.

With regard to the spatial, she proposes three basic concepts be attended to. These include: the appearance and disappearance of objects; the mutation of objects; and the movement of objects. Mutation describes content-based changes that may occur in the type of information represented (i.e. changes at nominal, ordinal or quantitative levels). Then in movement an object may be seen to move along a trajectory or else change its size/shape, which Blok terms a 'boundary shift' (2005:54-55).

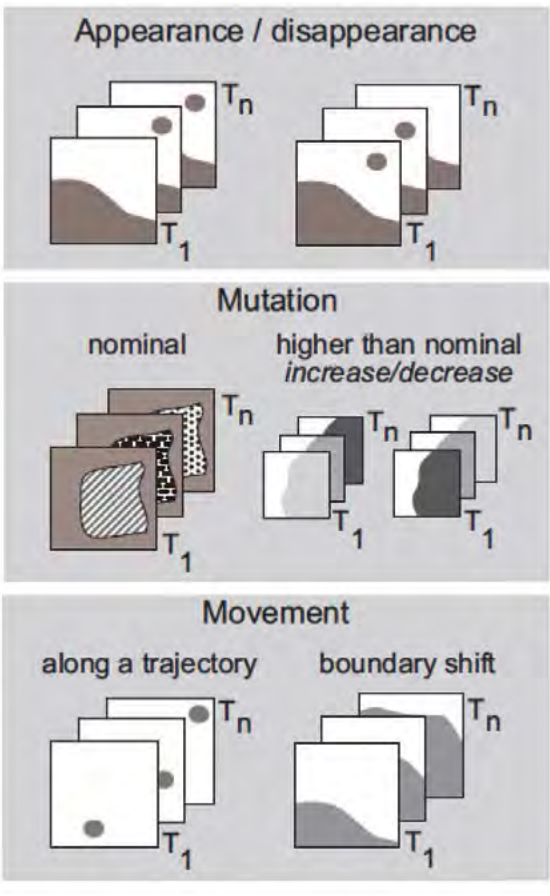


Fig. 6.33 Changes in the spatial domain of an animated cartographic representation according to Blok (2005:55).

With regard to the temporal, by reducing and renaming the dynamic variables proposed by MacEachren (1995), Blok frames her own personal set of variables. Thus, rather than display date, rate of change, order, duration, frequency and synchronisation, she presents:

- moment of display (analogous to MacEachren's display date);
- order;
- duration;
- frequency.

Blok's definitions of each of these variables are provided on the below table.

Variable	Blok's Definition
Moment of display	'Position of a state or a change in the representation in display time' (Blok 2005:65).
Order	'Structured sequence of states in the representation in display time' (ibid).
Duration	'Length of display time of a state or change in the representation' (ibid).
Frequency	'Repetition of a number of identical states or changes in a representation per unit of display time' (ibid).

Table 6.4 Blok's (2005) dynamic variables and their definitions.

This reduction of MacEachren's set of variables, arises from Blok's assertion that *frequency* and *synchronisation* should be understood not as dynamic variables but rather as *effects* resulting from the interaction of the user (2005:65).

In addition to this reduction and renaming, Blok also imposes a hierarchy on her variables. Here, moment of display is presented as a basic variable which then initiates an *order* and a *duration*, which she sees as primary. Thereafter, order and duration beget frequency, i.e. order and duration allow one to derive a particular frequency in relation to particular states or changes (ibid). This hierarchical relationship is set out on Blok's diagram below.

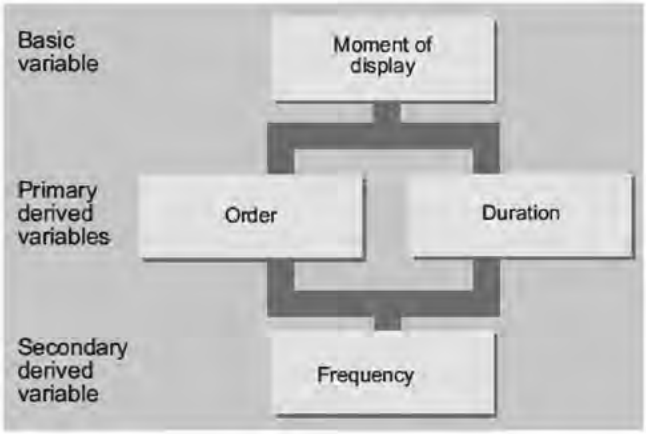


Fig. 6.34 The relationship between Blok's dynamic visual variables (Blok 2005:66).

In addition to these separate framings of the spatial and the temporal, Blok also proposes that overall spatiotemporal changes, observed for an extended period, may be seen to fit within one of two forms of pattern, a *cycle* or a *trend* (Blok 2005:58). For Blok, a cycle refers to a 'periodical return' to a prior state or sequence of changes. A trend, on the other hand, presents the opposite outcome, wherein objects in the display are seen to move away from one state and towards another, i.e. no return is observed (ibid). Beyond these, Blok also proposes that, when no cycle or trend is discernable, a pattern may be termed *unstructured*.

Having reviewed a selection of perspectives relating to spatiotemporal change in graphic representations, we are now in a position to reflect on these with a view to synthesising an overarching approach applicable to graphic syntax theory.

In terms of the temporal, the view is taken that MacEachren's work on dynamic variables (1994) has been surpassed by Blok (2005). Here, her reduction and simplification of MacEachren's proposal (1994) is seen as clearly reasoned (e.g. excluding synchronisation on the basis that it results from interaction). Further, it is felt that her hierarchical approach to the variables (e.g. identifying order and duration as primary) would allow for easy application in analysis, in so far as an operative sequence is now offered. Thus, Blok's set of dynamic variables is selected as the most appropriate system for dealing with the *temporal* aspects of change.

Next, in terms of the spatial, we may draw some insight from Blok's proposals. In particular, her notion of 'movement along a trajectory' allows for the simple description of an object's movement. Beyond this however, the view is taken that some of Blok's other proposed concepts are too domain specific (i.e. focused on the particularities of cartographic animation). For example, she proposes the concept of 'boundary shift' for instances where an object retains its identity but alters in shape/size (2005:55). This notion that an object has a 'boundary' may apply in the context of monitoring spatial phenomena (e.g. weather patterns) but is less relevant to more general understandings of spatial change in graphic representations. Thus, by way of alternative, we may look to Engelhardt's approach to visual attributes (2002:25-28), where spatial visual attributes (e.g. size, shape, orientation) are discussed alongside area fill visual attributes (e.g. colour and texture). Following this approach, it would seem more appropriate to propose that the *spatial* visual attributes, along with the *area fill* visual attributes may undergo *transformation*.

In addition to the above distinctions, as was stated earlier, Hornsby and Egenhofer's (1997) proposed system is seen to offer a comprehensive wide-ranging approach to describing object-based changes, which may be easily linked to graphic syntax theory. Therefore, it is selected as a system for dealing with the spatial aspects of change at a structural level, wherein the appearance/disappearance, combining and splitting of objects is being considered.

Gathering the above, in terms of the spatial we are thus able to discuss:

- The movement of objects;
- The transformation of the visual attributes of objects (e.g. size, shape, colour);
- Object-based changes (i.e. the appearance/disappearance, combining and splitting of objects).

It is proposed that all of the above concepts may together be thought of as allowing for a discussion of change at the object-level.

Having thereby identified approaches for dealing with the temporal and spatial aspects of change separately, we must now consider how spatiotemporal change over longer periods will be described. Here, we turn to Blok's notion of 'overall' spatiotemporal patterns. While her proposed system of cycles, trends and unstructured patterns is useful, it is also seen as lacking in that it does not allow for the description of spatiotemporal changes which are seen to result from a user's actions/interactions (i.e. changes which are not cyclical, trend-based or unstructured but rather responsive to input). Thus, in order to account for such change a new pattern termed 'responsive' is proposed. A responsive pattern would refer to instances of spatiotemporal change in a graphic representation wherein a user's actions/interactions are seen to direct the movement of graphic objects over time.

With the above selections in place, we are now in a position to present a means by which spatiotemporal change in a graphic representation may be described. The proposed sequence for description is set out in figure 6.35 below.

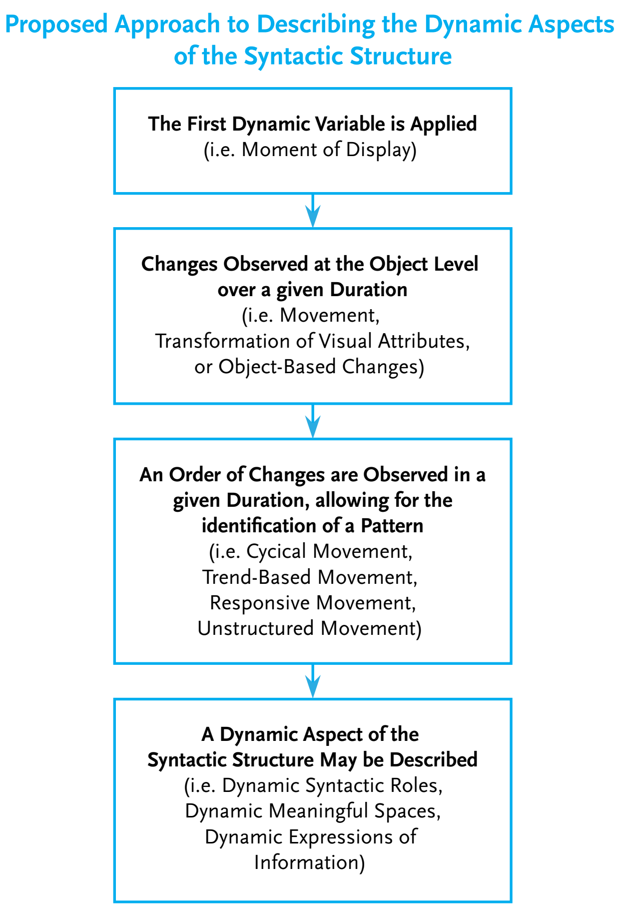


Fig 6.35 The proposed approach to defining the dynamic aspects of the syntactic structure. Here, it is suggested that through an application of the dynamic visual variables, spatial changes may be observed, which in turn allow for the identification of patterns and thereafter a description of the dynamic aspects of the graphic representation.

Following the above sequence, a set of temporal parameters are first defined. Here, a *moment of display* (i.e. a point in time) is identifed and thereafter a *duration* for which the representation is to be observed must be decided upon. Within this duration, an obseravation of object-level changes in the graphic representation is made. Here, alongside considering whether objects are seen to move (Blok 2005:55) or whether their visual attributes undergo a transformation (e.g. the colours change), object-based changes are also considered (e.g. an object is created). Hornsby and Egenhofer's (1997) types of change provides a listing of the possible object-based changes which may occur (see above for listings of the possible types of change which may occur). Next, having observed an *order* (i.e. a sequence) in these spatiotemporal changes over a relatively long period of time (i.e. an extended duration), observations may be aligned to particular pattern of spatiotemporal change, i.e. either cyclical, trend-based, responsive or unstructured.

Following the above sequence, it is suggested that the newly reformulated and progressed concepts of the proposed additional analytic level for graphic syntax theory (see Section 6.3.2.1 above) may be described. Thus, in addition to being able to account for the interactions of an independent user, we are now also able to deal with the transformation of the representation and dynamic graphic objects. Accordingly we are now able to apply our new analytic level in a direct analysis of the dynamic and interactive aspects of the prototype.

6.3.2.3 An Analysis of the Dynamic and the Interactive Aspects of the Prototype Interface

In analysis of the prototype interface's dynamic and interactive aspects we must first assume that the prototype is being viewed by a user who—in a given context, in a given spatiotemporal episode—has a task. Thus, let us posit that the prototype interface is being briefly viewed by a user seeking to gain a sense of their orientation, while walking a short distance along the test-route (i.e. the site for which the interface was designed).

From this, it is now appropriate to nominate an interaction, which triggers a transformation in the graphic representation. In the case of the prototype, this is a simple button press. Taking the button press as our 'moment of display', i.e. the point in time wherein change commences (MacEachren 1995:281), we may note that this results in the *creation*, i.e. the appearance (Hornsby and Egenhofer 1997:18), of a composite graphic object. From this, we may define a duration for which this composite graphic object shall be observed. In the present case, it is not necessary to specify a specific *duration* (i.e. an exact number of minutes/seconds) beyond simply restating that the interface is viewed for a brief period, as was posited above. Thereafter we may note the *order* of the movements/changes, which are seen to take place. Here, it will first be observed that no further object-based changes occur (i.e. no objects appear/disappear, combine or split). Nor do the visual attributes undergo transformation during the brief duration. Rather the labelled nodes representing landmarks, districts and a river—identified within the initial graphic syntax analysis—are seen to *move in response* to the user's actions (i.e. exhibit a responsive pattern of movement over time). In other words, as the user advances along the test-route or shifts in their immediate position, they will notice that the lineups of labelled nodes also move as they maintain a literal correspondence with the order and direction of the represented landmarks, districts and river.

Having identified the above we may now integrate these observations within the first iteration of the graphic syntax (see Section 6.3.1.4). Looking below, we notice the integrated observations are highlighted in bold.

> *Syntax of the Spatial Structure*: **On button press** a *distorted integral metric space* with multiple **responsively moving** *labelled nodes* (representing landmarks, districts and a river), which in turn are clustered around a central static labelled node (representing the user's location), **is created**.

> *Type of Correspondence*: Spatial structure: The order and direction of the landmarks, the districts and the river involves literal correspondence, while their positioning involves *distorted literal* correspondence. Elementary graphic objects: Literal pictorial representation is applied at times for the representation of landmarks. Additionally non-pictorial arbitrary abstract shapes and text are also applied for landmarks. For districts and the river arbitrary abstract spaces are applied. Visual attributes: The colours of some nodes involve literal correspondence (e.g. blue for the river), while the colours of others involve arbitrary correspondence (e.g. orange for the districts).

> *Type of Graphic Representation*: An orientation map.

Thus, the viability of this approach to analysis is demonstrated and we have a graphic syntax, which takes the dynamic and interactive aspects of the interface into account.

Before proceeding to the next section, the proposed extension of Engelhardt's graphic syntax framework (2002) that enabled the above analysis, will be commented on.

6.3.2.4 Positioning the Extension of Engelhardt's Graphic Syntax Framework as a Major Contribution of the Enquiry

As the proposed extension of Engelhardt's graphic syntax framework (2002) may be seen to carry an implication for information design theory, which has arisen out of the conduct of this research, it forms a partial response to the second research question (see Section 1.1). Consequently, it is presented as a major contribution of the enquiry.

However, a final step required. The extension's additional analytic level must be named. In seeking a name, we shall follow the original semiotic distinctions made by Morris (1938), and developed by Goldsmith (1978;1980). That is, the syntactic, the sematic and the *pragmatic*.

Here, the term pragmatic is deemed appropriate for, according to Goldsmith, a pragmatic level 'implies interpretation by a viewer' (1980:205). In taking this position, it is acknowledged that Goldsmith's understanding of pragmatics is specifically concerned with how a viewer's cultural and developmental background might affect their understanding of an illustration (see Section 2.1.4). However, it is held that the introduction of a viewer/user not only allows for the notion of interpretation but also the consideration of temporality and interaction. These concepts, in turn, allow for the consideration of the dynamic aspects of the syntactic structure, as has been demonstrated in the preceding section.

Having presented the above extension as a major contribution of this enquiry, it is important draw attention to the fact that no inventory of the dynamic and interactive shall be offered here. For example, no definitive listing of the possible dynamic syntactic roles shall be set out. Further, no attempt is made at developing a taxonomy of dynamic and interactive graphic representations. Both aspects are seen as beyond the scope of the present enquiry. Rather, it is intended that the provision of an additional analytic level within Engelhardt's framework (2002) will enable the description of the dynamic and interactive, which in turn may eventually lead to such inventories and taxonomies. This is discussed in further detail Sections 7.7 and 7.8, wherein the limitations of the enquiry, as well as areas for future research are set out respectively.

Having developed the interface's graphic syntax such that the dynamic and interactive has been taken into account, this new syntax will now be *contextualised* (i.e. linked to the context of the enquiry).

6.4 Presenting the Contextualised Graphic Syntax for the Design of a GPS-enabled Wayfinding Interface to Visually Support an Urban Recreational Walker's/Wanderer's Situation Awareness in Use

In order to contextualise the graphic syntax of the interface's design, it was necessary to return to the original source point for the design hypothesis (i.e. the interview participant (IP) group), as well as to the data collected through the semi-structured interviews that were conducted in the prototype test. Having retrieved this data, it was then reduced and linked to the graphic syntax (see Section 6.3.2.3).

This process, along with the final *contextualised* graphic syntax, is presented below.

6.4.1 *Contextualising the Graphic Syntax*

The contextualisation of the graphic syntax rested on the interweaving of the following three strands:

- The background of the IP group;
- An overview of participants' information design experience in the prototype test, i.e. their interpretation of the interface's structure (see Section 5.4.4.3);
- The meanings participants ascribed to the interface, i.e. what they thought it was for (see Section 5.4.4.4).

The IP group's background provides us with the who-where-when, from which the design hypothesis emerged. Then, the overview of participants' interface design experience in the prototype test provides us with a 'what'. That is, what was experienced in terms of the interface design's structure. Finally, the meanings participants' ascribe to the interface provide us with a 'how'. That is, how the interface was interpreted. The two latter strands are seen to compensate for our sidelining of the aspect of cognitive processes in relation to a viewer's/user's interaction with a graphic representation (see Section 6.3.2.1). Thus, rather than cognitive processes, we have the viewer's/user's interpretations and meanings.

Having assembled the above elements, the design hypothesis was returned to (see Section 4.3). Here, the graphic syntax and the various accompanying strands were integrated such that the hypothesis was placed in context and divided into a series of statements, forming a set of principles; all of which is seen to annotate (Gaver 2012) the interface's design, i.e. the artefactual contribution. In this process, the syntax was edited so as references to the test-route and the button-press interaction (i.e. the interaction which triggered the 'creation' of the graphic representation) were removed. This removal was seen to result in a clearer overview of what was held to be 'the essence' of the design.

With the above aspects in place, it was lastly decided that rather than present the enquiry's contextualised graphic syntax solely in narrative form, i.e. through text, it would instead be presented graphically and thereafter appended with a textual overview. This approach is seen as permissible and, indeed, desirable within the context of a practice-based enquiry.

Thus, in the next section, the final contextualised graphic syntax is presented as a graphic representation with an accompanying textual overview.

6.4.2.1 *The Third Major Contribution: A Contextualised Graphic Syntax for the Design of a GPS-enabled Wayfinding Interface to Visually Support an Urban Recreational Walker's/Wanderer's Situation Awareness in Use*

Figure 6.36 presents the final contextualised graphic syntax. In setting out a series of design principles, it provides an outline for the design of a GPS-enabled WI to visually support an intrinsically motivated urban recreational walker's/wanderer's situation awareness in use and, so, may guide/inform future designs.

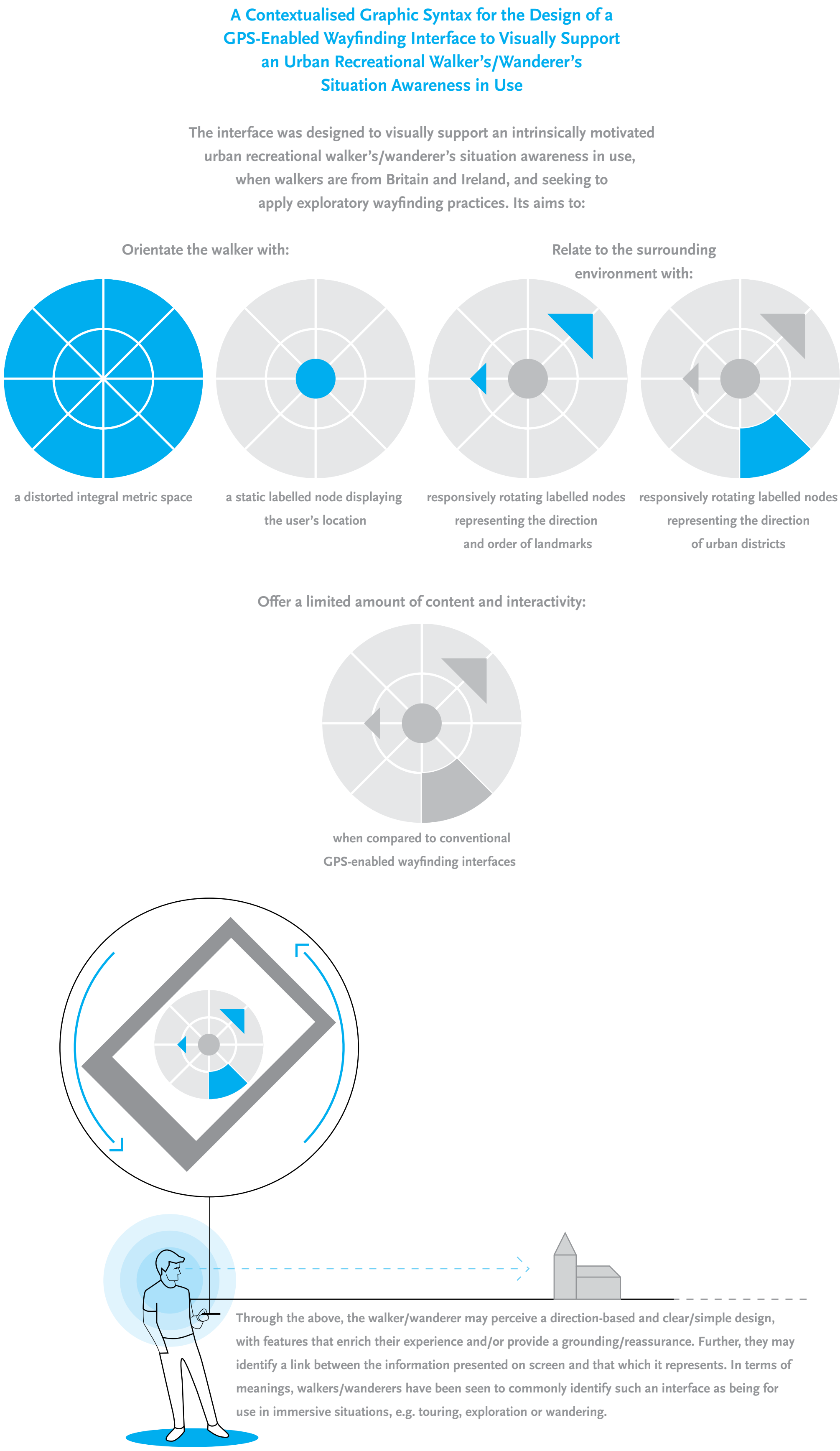


Fig. 6.36 The enquiry's final visual contextualised graphic syntax providing a set of principles for the design of a GPS-enabled WI to visually support an urban recreational walker's/wanderer's SA-in-use.

The above visual contextualised graphic syntax may be stated textually as follows:

This GPS-enabled wayfinding interface was designed to visually support an intrinsically motivated urban recreational walker's/wanderer's situation awareness in use, when such walkers are from Britain and Ireland, and seeking to apply exploratory wayfinding practices. Its aims to:

- Orientate the walker/wanderer with a static labelled node displaying their location within a distorted integral metric space.
- Relate to the walker's/wanderer's surrounding environment through responsively moving labelled nodes, involved in a literal correspondence with the direction and order of landmarks and districts.
- Offer a limited amount of content and interactivity as compared with conventional navigation-based wayfinding interfaces (e.g. Google Maps, circa 2015).

Through the above, the walker/wanderer may perceive a direction-based and clear/simple design, with features that enrich their experience and/or provide a grounding/reassurance. Further, they may identify a link between the information presented on screen and that which it represents. In terms of meanings, walkers/wanderers have been seen to commonly identify such an interface as being for use in immersive situations, e.g. touring, exploration or wandering.

This contextualised graphic syntax constitutes the final major contribution of this enquiry. It is seen to provide a response to both the first and second questions (see Section 1.1). In responding to the first question, it provides a set of principles for designing a GPS-enabled WI to visually support an urban recreational walker's/wanderer's SA-in-use and, so, may guide/inform future designs. In responding to the second question, these principles are seen to link to information design theory on the basis that they begin to provide practical guidance regarding a particular recreational wayfinding use-context (i.e. urban recreational walking/wandering). (See Section 7.6 wherein the contributions are discussed in further detail).

Additionally, in order situate the above contextualised graphic syntax within contemporary discourse, Appendix F offers a comparison of its principles and those set out in conventional situation awareness literature.

This marks the end of the enquiry; the next chapter will provide a summary and conclusion for the whole.

Summary

In this chapter the qualitative and quantitative results from the prototype test were integrated and assessed for the support of SA-in-use. Such an assessment made it possible to ascertain whether or not the design hypothesis had been verified.

The chapter was divided into four sections. In the first section the qualitative and (qualitized) quantitative results from the prototype test were integrated. In doing so, the patterns of experience and behaviour across the group were revealed. This, in turn, allowed for the assessment of SA-in-use for individual participants. In assessment, it was found that in the majority of cases SA-in-use was likely to have been supported and, as such, the design hypothesis was verified. Then in the second section, from this verification, the prototype's interface design was outlined and presented as the first major contribution of the enquiry. Next, in the third section, the results of a graphic syntax analysis of the prototype's interface design (Engelhardt 2002) were set out. From this, in the third section, consideration was given to how the interface's dynamic and interactive aspects might be attended to. Herein, an extension of Engelhardt's graphic syntax framework was proposed and subsequently positioned as a major contribution of the enquiry. Lastly, the fourth section drew the whole together by presenting the final major contribution of the enquiry: a contextualised graphic syntax which may be seen to annotate (Gaver 2012) the interface design, i.e. the artefactual contribution. In setting out a series of principles, it provides an outline for the design of a GPS-enabled WI to visually support an urban recreational walker's/wanderer's situation awareness in use and, so, may guide/inform future designs. These principles may also be linked to information design theory on the basis that they begin to provide practical guidance regarding a particular recreational wayfinding use-context (i.e. urban recreational walking/wandering).

7.
Summary and Conclusion

This chapter concludes the thesis and, as such, provides an overview of the enquiry, its contributions and limitations, alongside setting out possible directions for future research. It is comprised of eight sections. The first section offers a brief overview of the enquiry. Then, in the second, third, fourth and fifth sections a summary of the enquiry's methods and results is provided. From this, in the sixth section, the enquiry's contributions to knowledge are set out. Next, the seventh section addresses the enquiry's limitations. Finally, in the eighth section, possible directions for future research are highlighted.

7.1 The Enquiry in Overview

This research was motivated by a desire to explore how novel information design approaches to wayfinding interfaces (WIs) might better support the user-experience within particular use-contexts. Focus was directed towards the activity of urban recreational walking/wandering. During the course of the enquiry, two research questions were devised. Namely, how can GPS-enabled WIs be designed to visually support an urban recreational walker's/wanderer's situation awareness in use? Then, from this, what are the resultant implications for information design theory and what recommendations can be made to information design practice?

The enquiry proceeded through two phases. In the first phase, a programme of semi-structured interviews with urban recreational walkers/wanderers was enacted. This allowed for the identification of how the activity was approached and practiced. It also allowed for the identification of how these walkers made use of, and perceived, current GPS-enabled WIs. The latter results provided material against which an area for experimentation could be framed and a design hypothesis formulated.

Then, in the enquiry's second phase, a series of design experiments were conducted in order to develop a novel WI in response to this hypothesis. Here, a development cycle was pursued, leading eventually to the design of a mixed-fidelity working prototype.

This prototype was then trialled through the application of qualitative and quantitative methods of data collection and analysis. By integrating the results obtained therein, it was possible to assess whether or not situation awareness in use (SA-in-use) had been supported against the statement which had been set out in relation to this in the enquiry's conceptual framework (see Sections 2.4 and 2.3.7). Assessment revealed that the interface was likely to have supported SA-in-use in the majority of cases and so the hypothesis was verified. From this, the prototype's interface design was presented as a *practical response* to the first research question and so was positioned as an artefactual contribution to knowledge.

Then, through a graphic syntax analysis (Engelhardt 2002) of this artefact, a contextualised graphic syntax *for* design was generated. In setting out a series of principles, it provides an outline for the design of a GPS-enabled WI to visually support an urban recreational walker's/wanderer's situation awareness in use and, so, may guide/inform future designs. Accordingly, it was presented as another major contribution of the enquiry.

Further to this, in graphic syntax analysis, a reflection on the dynamic and interactive aspects of the interface led to an extension of Engelhardt's graphic syntax framework (2002) being proposed. In identifying an implication for information design theory, this extension was presented as another major contribution of the enquiry.

From the above, we will now move to summarise the enquiry's methods and results in more detail. Let us begin with the programme of semi-structured interviews conducted in the enquiry's first phase.

7.2 The Semi-Structured Interviews

In the semi-structured interviews a dual programme of purposive and snowball sampling was applied (see Section 3.2.1), resulting in a varied, yet ultimately connected group of thirty-one participants being recruited.

During the interviews with these participants, a number of questions sought data relating to:

- Participants' motivations to walk/wander;
- Their exploratory wayfinding practices;
- The wayfinding resources they drew upon while walking/wandering;
- Their use of GPS-enabled WIs;

- The positives and deficits of GPS-enabled WI use.

Analysis of this data was guided by an 'interpretative phenomenology' (Smith et al. 2009) specifically termed interpretative phenomenological analysis (IPA; see Section 3.2.5). In applying IPA, the researcher aimed to *interpret* how participants had made *sense* of their own *experience*.

The analytic process was initiated through the reading of the transcript texts, wherein the progressive annotation of the text took place. In common with thematic analysis (Bryman 2008:578) annotation gave way to coding, which allowed for the development of themes. Once the basic themes were refined and consolidated, it was then possible to identify broader, organising themes, allowing for the general grouping of the data. Additionally, a series of visual mappings were developed as a means of identifying those basic themes, which were emerging most frequently.

In this way, key themes were identified in relation to participants' motivations to walk/wander, their experience of exploratory wayfinding, as well as their use of wayfinding materials in general and GPS-enabled technology in particular.

With motivations, it was possible to group the basic themes into two simpler organising themes: *intrinsic* motivations and *extrinsic* motivations (see Section 4.2.1). Beneath these, three key themes were identified. Here, participants were frequently *intrinsically* motivated by the themes of *exploration* and *to see*, and *extrinsically* motivated by the theme of *exercise*.

In considering participants' experience of exploratory wayfinding it was possible to identify a number of *components* of the practice emerging from within the data. Here, two broad organising themes were identified: *tactical* components, and *experiential* components (see Section 4.2.2). In terms of *tactical* components the following were seen to emerge frequently: *taking emergent paths, directional movement, compelled by the immediate, linking to the familiar*, and *exploration*. Alongside these, the experiential component of *noticing* was also prominent.

With regard to the wayfinding resources participants drew upon in urban recreational walking/wandering four broad themes were identified: *environmental resources, artefactual resources, social resources* and *embodied resources* (see Section 4.2.3). In terms of specific themes, it was revealed that participants most often drew upon: the artefactual resource of *mobile* *maps*; the social resource of *other people*, the artefactual resource of *paper maps and guides*, the environmental resource of *landmarks*; and the embodied resource of *intuition*.

From the above, in regard to preferred map features, the themes of: *landmarks*, *parks/opens spaces* and the *you are here representation* emerged most prominently (see Section 4.2.3.1).

With participants' use of GPS-enabled WIS, it was found that many did not use the technology. Some simply did not own a smartphone; others, however, held particular reservations regarding the use of GPS-enabled WIS. In regard to those who *did* use the technology, it was possible to identify a number of prominent priority-use themes (see Section 4.2.4). Here, participants were seen to use such interfaces for: *orientation*, *navigation*, *planning* and *checking*. Of these, *orientation* emerged most prominently. Here, participants claimed that in using GPS-enabled WIS they sought to gain a *general* understanding of 'where' they were. With the other priority-use themes it appeared that participants were seeking highly *specific*, *detailed* information in order that they might confidently make decisions in regard to their route choices.

In identifying the positive and deficits of GPS-enabled WIS, participants referred not only to their role within experience, but also to technical and interactive aspects. With regard to the perceived positives, two prominent themes were identified: *a sense of security* and *not getting lost* (see Section 4.2.5). With regard to the perceived deficits, in focusing on the *experiential* deficits, the most prominent themes identified were: *undermines situation awareness* and the *negation of exploratory wayfinding* (see Section 4.2.6).

From the above, the researcher moved to frame an area for experimentation. In order to aid this process, two final mappings of the data were produced. The first grouped participants' *intrinsic* motivations and, in turn, linked these to their priority-uses or type of non-use, as well as to the particular *experiential* deficits identified. The second mapping made the same links but showed *extrinsic* rather than *intrinsic* motivations. The view was here taken that the former group (i.e. those with intrinsic motivations) found value in walking/wandering in and for itself. As such, in constrasting both perspectives, it was this group to which the researcher sought to attend.

Comparing both mappings, it was found that a large of portion of those who are *intrinsically* motivated did not use GPS-enabled WIS on the basis of conviction. Further to this, *undermines situation awareness* and the *negation of exploratory wayfinding* emerged as *significant* issues in relation to the use of GPS-enabled WIs only for those who were *intrinsically* motivated. In some cases, through close analysis, it was possible to contextualise these issues as *barriers*-to-use.

From this, an area for experimentation was framed. Herein, focus was directed toward designing a GPS-enabled WI to support an intrinsically motivated urban recreational walker's/wanderer's situation awareness in use, while also ensuring that exploratory wayfinding practices were still possible. It was then hypothesised that such an interface would:

> *orientate the urban recreational walker in relation to their surrounding environment with minimal content and interactivity.*

This hypothesis was seen to launch the enquiry's second phase, wherein a series of design experiments were conducted in response. We now turn to consider these.

7.3 The Design Experiments

In the enquiry's second phase, three separate design experiments were conducted: the exploratory designs, the field simulation test, and the prototype test. The exploratory designs and the field simulation test were generative, i.e. a development cycle was pursued. From this, a mixed-fidelity working prototype was designed and trialled through the application of qualitative and quantitative methods of data collection and analysis. It was here intended that an assessment of the integrated results would later allow the researcher to ascertain whether or not the design hypothesis had been verified. We will now look at each experiment and its results in turn.

7.3.1 The Exploratory Designs

The exploratory designs allowed for the rapid development of possible interface designs containing the features that were seen to converge within preliminary design work, i.e. sketching (see Section 5.1.2). Herein, three areas of focus were identified: types of graphic space, landmarks and the you are here representation. Abductive reasoning (i.e. the application of imaginative thinking on the part of the researcher) was applied in order to develop an array of four *alternative* designs for each area of focus. These arrays were then presented to participants in order that the *semantic accessibility* of the designs might be informally tested.

From the exploratory designs, the field simulation test was launched.

7.3.2 *The Field Simulation Test*

The field simulation test involved the trialling of *simulated* interface designs in 'natural' settings of use, i.e. in outdoor urban locations in the city of Glasgow, with fifteen participants.

7.3.2.1 *Designing the First Field Simulation Design*

In designing the first field simulation (FS) design, the researcher sought to reapply features, which had been developed in the exploratory designs. Here, through the imposition of internal, *designer-imposed* constraints (Lawson 2006/1980:93) focusing on the potential for alignment with the design hypothesis and the results of analysis of the semi-structured interviews (i.e. the data of the enquiry's first phase), as well as giving thought to technical considerations, a number of straightforward decisions were made.

The resultant design included: a circular 'egocentric' graphic space; a larger circular you are here representation; and a 'semi-realistic' approach to landmark representation. Additionally, the interface was programmed to *rotate* in accordance with the data drawn from sensors on the iPhone 4S (i.e. the test platform; see Section 5.1.1).

7.3.2.2 *The Field Simulation Test*

The field simulation test was divided into two parts. First, participants were given an orientation task, wherein Google Maps was used. Then, they were given another orientation task wherein an FS design was used. Focus was directed towards participants' experience of the FS design in relation to the surrounding environment, as well as to their interface-environment (I-E) interactions, i.e. to their behaviours in use. Accordingly, participants were videoed in use and, afterwards were asked to *openly* evaluate the interface design.

7.3.2.2.1 *The Results of Analysis of the Open Evaluations*

In analysing participants' open evaluations of the interface, the researcher sought to identify, on the one hand those features, which were perceived to be *positive* and, on the other, what might be termed *negatives*. In considering the negatives it was necessary to return to the design hypothesis and judge whether or not the feedback was relevant. That is, whether or not it aligned with the design's point of origin. If an issue was deemed relevant, then it was subsequently responded to in the next design. Through this process seven separate FS designs were developed in iteration. Herein, the following key adaptions were made:

- In FS#4, in seeking to indicate the position of key landmarks, triangles were included around the periphery of the interface;
- In FS#5, an attempt was made to differentiate between near and far, by placing 'far' features at the edge of the interface and 'near' features closer to the centre;
- In FS#6 the size of the you are here representation was increased significantly;
- FS#7, the final FS design, combined all of the above adaptions.

Reviewing the whole, despite some objections, many participants were appreciative of the directionality of the FS designs, while others approved of the emphasis on geographic and cultural landmarks.

Analysis of the open evaluation data was paralleled by analysis of the observation data.

7.3.2.2.2 *The Results of Analysis of the Observation Data*

While observing participants' use of both Google Maps and the FS designs, focus was directed towards two particular behaviours. The first related to the frequency of participants' upward glances/gazes (i.e. how often they were seen to *look up* from the interface); as this was seen as indicative of the extent to which their attention was distributed between the interface and the environment. The second related to the way in which participants moved to orientate their body in use (i.e. if they turned to align themselves with the arrangement of the interface).

From observation, each participant's paired set of results were arranged in a case-series (Farringdon et al. 1996). Through variance analysis, it was found that, with regard to looking up, the majority of participants were seen to look up *more* often while using the FS designs. Equally, with regard to the amount of body turns performed in each part of the test, it was found that the majority of participants were more likely to turn their body while using the FS design.

7.3.2.2.3 *The Transition Point between the Field Simulation Test and Prototype Development*

After testing FS#7, i.e. the last FS design, the researcher made three observations. Firstly, it appeared that, despite some objections, the essential features of the FS designs appealed to many participants. Secondly, when comparing the levels of I-E interactions observed for both interfaces, the FS designs were performing better. Thirdly, it appeared that the structure of the latter FS designs had begun to converge. In other words, there were few discernable differences between FS#6 and FS#7.

Taken together, these three observations suggested that a satisfactory level of refinement had been reached. Accordingly, the view was taken, that in order to progress the research, a mixed-fidelity working prototype should be developed based on the structure of the final FS design (i.e. FS#7).

7.3.3 *The Prototype*

In moving to develop the prototype, the researcher first selected a test-route: a riverside path approximately one kilometre in length passing through in a large park known as Kelvingrove. From this selection, a number of prolonged site visits were undertaken. During each visit, the researcher paid particular attention to specific locations at which large, prominent buildings could be seen, as well as the city districts that the walker would be moving towards and away from. In this way a master list of key environmental elements was compiled.

Having compiled this list of elements, the prototype's technical architecture was then considered. Here, it was envisaged that the prototype would be presented on a single webpage containing a single button. By pressing this button, the site would query the device's coordinates and compare this data to a pre-defined array of possible coordinates. If a positive match was made, then a location-specific image, would be downloaded and appear on screen. As with the FS designs, it was also intended that this image would be programmed to *rotate* in accordance with the data drawn from the iPhone 4S's sensors.

Taking this approach, then, it was necessary to develop a set of unique images/WIs to appear at particular locations along the route. In order to define these locations, the decision was taken to divide the route into a number of sections, which might then be linked to the specific representation (i.e. a unique image would be produced for each section). Once the route was divided into sections, the next step taken was to define the relations between each section and the environmental elements on the master list.

Having collected this data, a set of unique images/WIs were developed to display the newly defined section-based relations (see Appendix C for a detailed outline of the researcher's thinking here). The final design appeared on a single webpage, with a single button reading 'Map Me'. On pressing the button, a unique, location-specific, rotating representation appeared on screen.

From development, the test began.

7.3.3.1 The Prototype Test

The prototype test was divided into two parts. First, participants were given a Google Maps orientation task. Then, they were asked to walk along the test-route and, therein, to 'use' the prototype at least twice. Twenty-one participants took part.

Qualitative data collection was enabled through a semi-structured interview looking at: participants' *experiences with* the prototype (i.e. what happened); their *experiences of* both interfaces (i.e. what each was *like*); their *information design experience* and the *meanings* they ascribed to the prototype (i.e. what they thought it was for).

It was intended that data collected in regard to participants' *experiences with* the prototype would be assessed for the components of exploratory wayfinding, identified in the enquiry's first phase (allowing the researcher to judge whether or not exploratory wayfinding practices might still be possible in use; see Section 4.2.2).

Next, it was intended with the data collected in regard to participants' *experiences of* both interfaces would be integrated with the *quantitative* data collected through observation (allowing for an assessment of whether or not SA-in-use had been supported against the statement regarding this, set out in the conceptual framework; see Sections 2.4 and 6.1).

Thereafter, it was intended that data collected in response to the remaining lines of questioning would eventually allow for the generation of a contextualised graphic syntax *for* design (Engelhardt 2002; Zimmerman et al. 2010; see Section 3.3.9).

Quantitative data collection was enabled through the observation of participants' I-E interactions in their use of Google Maps and their first instance of use of the prototype. The researcher here attended to the *amount* of times participants looked up from each interface (i.e. the frequency), as well as the total *length* of time participants looked up for (i.e. the duration).

From observation, a variance analysis was performed on the data. Here, the results obtained for Google Maps were compared to those for the prototype. The former set of results (i.e. those obtained for Google Maps) were positioned as a contrasting baseline profile against which the latter results (i.e. those obtained for the prototype) might be contextualised. Thereafter, in order to allow for the later integration of this quantitative data, these results were qualitized (i.e. converted into qualitative form; see Sections 3.3.8.3 and 5.4.5.1).

We will first consider the results of analysis of the interview data.

7.3.3.1.1 *The Results of the Analysis of the Prototype Test Interview Data*

In qualitative analysis the researcher first assessed whether or not participants' *experiences with* the prototype suggested that exploratory wayfinding practices were still possible (see Section 5.4.4.1). Assessment revealed that all but two participants within the group were seen to have had experiences that could be reasonably matched to the components of exploratory wayfinding. Therefore, the results suggested that exploratory wayfinding practices were still possible in use.

Next, in an analysis of participants' *experience of* both interfaces, two broad organising themes were identified. Here, participants were either seen to take an *environmental focus* or *interface focus* (see Section 5.4.4.2). Beneath these, in terms of basic themes, with the prototype the *environmentally focused* theme of *immediate-relationality* emerged most prominently along with the *interface focused* themes of *direction-based relationality* and *egocentric relationality*. With Google Maps, the *interface focused* themes of *route-based* and *graphically dense* emerged most prominently alongside the *environmentally focused* theme of *challenging in orientation*.

Then, with regard to their *information design experience*, participants were seen to make reference to the interface on three separate levels: the whole interface; particular features of the interface; and the properties of particular features (see Section 5.4.4.3). With regard to the whole interface, many participants were appreciative of what they saw to be the *direction-based* and *clear/simple* design. In terms of particular features, many participants expressed an appreciation for the *symbols* and the *inclusion of monuments*. The inclusion of monuments in particular appeared to enrich participants' experience of the immediate environment. Additionally and similarly, the *inclusion of the river* and the *inclusion of the school* were seen to provide a 'grounding' and a sense of 'reassurance' respectively. Finally, with regard to the properties of individual features, some participants identified a link between the information presented on screen and that which was represented.

Lastly, in analysis of the *meanings* participants' ascribed to the interface, two broad organising themes were seen to emerge. Here, participants' meanings either suggested uses in *immersive* situations, wherein the user would be keenly aware of the surrounding environment, as well as their embodied involvement within it; or, alternatively, their meanings suggested uses in *prosaic* situations, wherein it was not apparent that they would be aware of their embodied involvement in the surrounding environment (see Section 5.4.4.4). At a basic level the themes of *touring* and *exploration/wandering*, which both suggested usage in *immersive* situations, were together seen to emerge most prominently.

7.3.3.1.2 The Results of the Analysis of the Prototype Test Observation Data

In comparing participants' use of Google Maps in the orientation task to their first use of the prototype on the test-route through a variance analysis, it was shown that participants were inclined to look up *more* (i.e. more frequently) and look up *for longer* (i.e. for a longer duration) with the prototype, over Google Maps.

Through a qualitization (Tashakkori and Teddlie 1998; see Sections 3.3.8.3 and 5.4.5.1) of the quantitative results, it was revealed that most often, participants *did not look up* with Google Maps and *looked up throughout* and *extensively* within their sampled use of the prototype.

We have thereby set out the methods and results of the design experiments. Let us now move on to consider the process of assessing the prototype test results for the support of SA-in-use.

7.4 Verification through Assessment

By integrating the qualitative and (qualitized) quantitative prototype test results, participants' patterns of experience and behaviour were revealed. Here, a number of observations were made.

Firstly, in the Google Maps orientation task it appeared that in exhibiting low I-E interactions the majority of participants took an interface focus. That is, the interface was conceptualised almost exclusively in terms of its visual or interactive aspects. As such, it would seem that in exhibiting low I-E interactions, their attention was directed almost exclusively towards the information presented on screen.

Secondly, in exhibiting high I-E interactions in their emergent use of the prototype it appeared that a majority of participants took an *environmental focus*. That is, the interface was conceptualised in terms of how it *directly related* to their surroundings or the wider context. Here, the view was taken that the prototype was likely to have been understood and that the high levels of I-E interactions exhibited were likely to be at least partly attributable to the design.

Thirdly, some participants exhibited high I-E interactions in their emergent use of the prototype, yet appeared to have taken an *interface focus*. Here, through close analysis, it was determined that these participants were still likely to have understood the interface. Additionally, it was also shown the high levels of I-E interactions exhibited were likely to be at least partly attributable to the design.

Therefore, taking the Google Maps orientation task as a contrasting baseline profile, it appeared that the prototype had supported meaningful higher I-E interactions for a majority of the group.

Thereafter these patterns were directly assessed in order to ascertain whether or not SA-in-use was supported for the majority of participants. Here, the researcher returned to the enquiry's statement in relation to how one might assert that an urban recreational walker's/wanderer's SA-in-use was supported (see Section 2.4 and 2.3.7). The statement provided a set of criteria against which assessment could take place.

In assessment, it was found that SA-in-use was likely to have been supported in the majority of cases. Thus, the design hypothesis was verified and the prototype interface was presented as a *practical response* to the first research question (see Section 1.1) and, as such, was positioned as a major (artefactual) contribution of the enquiry.

From this, the researcher moved to generate a contextualised graphic syntax for design (Engelhardt 2002; Zimmerman et al. 2010; see Section 3.1.2).

7.5 The Definition and Contextualisation of the Graphic Syntax: Extending Engelhardt's Graphic Syntax Framework

In moving to generate a *contextualised graphic syntax* for design (Engelhardt 2002; Zimmerman et al. 2010; see Section 3.1.2) a graphic syntax analysis (Engelhardt 2002, see Section 2.1.5) was first performed on the prototype's interface design, i.e. the artefact. In analysis, the following was identified.

The syntax of the spatial structure included a distorted integral metric space with multiple labelled nodes (representing landmarks, districts and a river), which in turn were grouped with a central labelled node (representing the user's location).

Then, with regard to types of correspondence, instances of literal correspondence and distorted literal correspondence were identified at the level of the spatial structure. With elementary graphic objects instances of literal pictorial representation, as well as abstract shapes were identified.

Lastly, in terms of the type of graphic representation, it was proposed that the interface be seen as an orientation map.

By reflecting on the application of Engelhardt's framework to the dynamic and interactive aspects of the interface, it was found that the approach did not allow for discussion of: the transformation of the representation (i.e. the appearance of a new representation); dynamic graphic objects (i.e. moving objects); or the interactions of an independent user within particular spatiotemporal episodes.

In order to allow for these aspects it was judged necessary to enfold an additional analytic level within the framework. Making reference to earlier work by Engelhardt (i.e. Blackwell and Engelhardt 2002) it was possible to propose that the additional concepts of physical/social context, spatiotemporal episodes, task and interaction be incorporated within this new level. Thereafter, it was proposed that concepts relating to the static syntactic structure be expanded into the additional analytic level such that each was seen to gain a *dynamic* quality. Thus, the concepts of: dynamic syntactic roles, dynamic meaningful spaces and dynamic expressions of information were proposed and defined within the limits of this enquiry.

With these new concepts in place, a means by which dynamic syntactic roles, dynamic meaningful spaces and dynamic expressions of information could be described was sought. This required that the researcher frame a system for discussing spatiotemporal changes in graphic representations.

Here, through a review of the literature, an overarching approach applicable to graphic syntax theory was synthesised through the interweaving of a number of separate contributions. Firstly, Blok's (2005) set of dynamic variables was identified as the most appropriate system for dealing with the *temporal* aspects of change (see Section 6.3.2.2). Then, in relation to the spatial, it was decided that Blok's notion of 'movement along a trajectory' (2005:55) allowed for the simple description of a potential object's movement. From this, following Engelhardt's approach to dealing with 'visual attributes' (2002:25; see Section 2.1.5), it was proposed that the *spatial* and *area fill* visual attributes might be seen to undergo transformation and, accordingly, this would be directly described. Lastly, Hornsby and Egenhofer's (1997) proposed system relating to the appearance/disappearance, combining and splitting of objects, was seen to offer a comprehensive wide-ranging approach to describing the object-based changes that may occur in a graphic representation. Further, the system could easily be linked to graphic syntax theory on the basis that an inherent distinction was made between changes which occur to single objects (i.e. elementary objects) and composite objects (see Section 6.3.2.2).

As a final step, in order to deal with the description of spatiotemporal change over longer periods, Blok's notion of 'overall' spatiotemporal patterns was followed (2005:58). Here, in addition to Blok's original set of patterns concerning cycles, trends and unstructured change, the concept of a responsive pattern was also proposed. A responsive pattern would refer to instances of spatiotemporal change in a graphic representation wherein a user's actions/interactions are seen to direct the movement of graphic objects over time.

Having proposed this extension of Engelhardt's framework to include an additional analytic level as well as a means by which spatiotemporal changes in graphic representations could be described, the interface was analysed anew. From this analysis, the original syntax was expanded to include: the type of interaction which triggered a transformation of interface (i.e. a button press); the 'creation' of a new composite graphic object on the basis of this interaction; and lastly, the responsive movement of the labelled nodes representing the direction and order of the landmarks, districts and river.

From this analysis, the researcher moved to contextualise the graphic syntax. Contextualisation rested on the interweaving of the following three strands:

- The background of the interview participant (IP) group;
- An overview of participants' information design experience in the prototype test, i.e. their interpretation of the interface's structure (see Section 5.4.4.3);
- The meanings participants ascribed to the interface, i.e. what they thought it was for (see Section 5.4.4.4).

Having assembled these elements, the design hypothesis was returned to (see Section 4.3). Here, the revised graphic syntax and the various accompanying strands were integrated such that the hypothesis was placed in context and divided into a series of statements, forming a set of principles; all of which is seen to annotate (Gaver 2012) the interface's design, i.e. the artefactual contribution. The final contextualised graphic syntax read as follows:

> This GPS-enabled wayfinding interface was designed to visually support an intrinsically motivated urban recreational walker's/wanderer's situation awareness in use, when such walkers are from Britain and Ireland, and seeking to apply exploratory wayfinding practices. Its aims to:
>
> - Orientate the walker/wanderer with a static labelled node displaying their location within a distorted integral metric space.
> - Relate to the walker's/wanderer's surrounding environment through responsively moving labelled nodes, involved in a literal correspondence with the direction and order of landmarks and districts.
> - Offer a limited amount of content and interactivity as compared with conventional navigation-based wayfinding interfaces (e.g. Google Maps, circa 2015).

Through the above, the walker/wanderer may perceive a direction-based and clear/simple design, with features that enrich their experience and/or provide a grounding/reassurance. Further, they may identify a link between the information presented on screen and that which it represents. In terms of meanings, walkers/wanderers have been seen to commonly identify such an interface as being for use in immersive situations, e.g. touring, exploration or wandering.

Thus, having summarised the enquiry's methods and results, we will now turn to consider its contributions.

7.6 The Contributions of this Research

The major contributions of this research are made to the field of information design. These contributions are threefold and will now be discussed in turn.

The first is a GPS-enabled WI, i.e. an artefact. This artefact offers a novel information design approach to GPS-enabled WIs for urban recreation walkers/wanderers and, as such, builds on the work of others investigating this area (e.g. Reichenbacher 2004, Meng 2005). It may be seen as a *practical response* to the first research question (see Sections 7.1 and 1.1).

The second is a contextualised graphic syntax *for* design (Engelhardt 2002; Zimmerman et al. 2010; see Section 3.1.2). In setting out a series of principles, this graphic syntax provides an outline for the design of a GPS-enabled WI to visually support a walker's/wanderer's situation awareness in use, and is applicable to information design practice. Further, its principles link to information design theory on the basis that they begin to provide practical guidance regarding a particular recreational wayfinding use-context (i.e. urban recreational walking/wandering). In terms of a direct theoretical linkage, it is seen to append to, and enrich, Arthur and Passini's discussion of 'recreational wayfinding' (1992:76). More directly still, by presenting a contextualised graphic syntax that is concerned with the use of GPS-enabled WIs and situation awareness in recreational walking/wandering, a potential solution is set forth in relation to one of the 'burdens' that Mollerup (2013) cited when discussing such interfaces, i.e. that in use the user may become 'locked to their smartphone' (p.160). Additionally, by focusing on the design of WIs for urban recreational walkers/wanderers, a response is also made to Reichenbacher's call for users' ways of acting in the world to be studied and 'mappings' between relevant information types and their 'presentations' to be identified (2004:153).

Beyond the field of information design, these contributions are also seen to offer a direct response to Brown and Chalmers (2003) who call for an interface design that affirms the user's direction 'at a glance' so as to offer a more appropriate form of support for wandering urban tourists. Then, by designing an interface that moves beyond the current design of map formats and, in doing so, seeks to address passive models of interaction, a response is also made to Willis et al. (2009:109), who speculated that such an approach may be desirable. (In order to review the original identification of these gaps, please turn to Section 2.3.6).

Beyond the above, a third major contribution is made to information design through an extension of information design theory. In particular, through the extension of Engelhardt's graphic syntax framework (2002; see Section 2.1.5), such that it includes an additional pragmatic analytic level, allowing for the description and incorporation of the dynamic and interactive aspects of graphic representations within graphic syntax. It is held that such processes of description may, in turn, allow for the development of inventories of the dynamic and interactive aspects of graphic representations, as well as possibly enabling the development of an expanded taxonomy of forms of graphic representations in the future.

These major contributions are accompanied by a number of minor contributions.

Of these, the first is a methodological contribution, made through the adaption of Bang et al.'s research-through-design diagrammatic model (2012). This adaption, though simple, demonstrates how other research techniques may be *explicitly* incorporated within the diagrammatic model in such a way as to be seen to aid the formulation of a hypothesis. As such, Bang's et al.'s operationalization of Koskinen et al.'s articulation (2011) of the research-through-design paradigm is enriched.

The second minor contribution is made through the literature review in Chapter 2, wherein a number of diverse theoretical perspectives from the fields of: phenomenological philosophy, human geography, anthropology, information design, wayfinding design, interaction design and ecological psychology have been interwoven. This interweaving is now made available to other researchers operating within or outwith any of these fields, as they seek to link the otherwise disparate domains that have been drawn together.

The third minor contribution is made through the semi-structured interview findings, which build on existing literature by providing further insight into urban recreational walker's/wanderer's practices. Here, in particular, this enquiry's focus on the experience of wandering adds to the knowledge that was generated in Middleton's broader study of urban walking (2010).

The fourth minor contribution is a viable HTML, CSS and JavaScript file, which allows for the presentation of rotating, context-aware graphic representations (see Appendix G; and the Memory Key). Through minimal adaption, this file may be reconfigured so as to be operable in other geographic locations. Thus, further testing of novel information design approaches to GPS-enabled WIS is technically possible.

The fifth and final minor contribution arises from the belief that this is the first enquiry to apply information design theory (i.e. graphic syntax theory) to the practice of designing a GPS-enabled WI in order to contribute to information design practice and theory. Accordingly, by subscribing to the essential outline of this enquiry, future practice-based research is offered a viable model to follow.

Having outlined the contributions of this research, let us now move on to consider its limitations.

7.7 The Limitations of this Research

Reflecting on the enquiry, there are a number of limitations, which should be noted here. These relate to the methodological, theoretical and practical aspects of the enquiry.

7.7.1 Methodological Limitations

In regard to the methodological limitations it is firstly acknowledged that, as was alluded to in Section 6.1.1, the attributability of participants' I-E interactions *solely* to the design cannot be justified. This is due to the tests having taken place in an uncontrolled field setting where there may have been other factors intervening, e.g. because participants were walking in use and so may have been tracking their forward path, or were simply confused. However, as we have seen, in the interview, most participants took an *environmental focus* in discussing their *experience of* the prototype, i.e. they spoke of how they felt the prototype *related* to the surrounding environment. It is maintained, that this latter result would *suggest* that the high level of I-E interactions seen across the group is, at least partly attributable to the *design* of the prototype interface.

Next, it is recognised that this enquiry presents the results of a single test cycle and does offer any indication of how, *longitudinally*, participants' experience and behaviour might adapt. Though it is the researcher's belief that patterns of experience and behaviour would maintain a basic shape, this cannot be known unless a prototype of sufficient robustness is developed and tested at regular intervals.

Finally, as has already been stated in the main text, due to the non-random sampling strategies applied (i.e. purposive and snowballing sampling) the results of the prototype test must be considered *non-generalisable* (see Section 3.1.2). That is to say, the results cannot be assumed to hold across a large population. However, as Goodman et al. point out (2012:315), this is often the case with prototype tests. By way of offset, it is hoped that—through the thick description here provided—the *transferability* (Lincoln an Guba 1985:316) of this enquiry is robust enough to enable future research to *trial* its results.

7.7.3 Limitations Relating to the Theoretical Contribution

In regard to the limitations relating to the enquiry's theoretical contribution, two key issues are acknowledged. Firstly, it is noted that no demonstration of the application of the additional pragmatic analytic level to other dynamic and interactive graphic representations has been offered. Secondly, it is also noted that no attempt has been made to develop inventories of the possible forms that the dynamic and interactive aspects of graphic representations may take. Nor, indeed, has any expanded taxonomy of possible types of graphic representations been offered.

In response to the first issue, it is held that the strength of the new analytic level must not be seen to rest solely on its framing, i.e. on the additional concepts. Rather its strength rests, on the sequenced approach to describing spatiotemporal change as set out in Section 6.3.2.2; for it is through this sequence that any grounding of the dynamic and interactive shall take place. Thus, it is the viability of the individual proposals, which comprise the approach that must be scrutinised. These proposals have arisen out of decades of enquiry (and debate), and demonstration has been dealt with directly in the context of each (e.g. Blok 2005; Hornsby and Egenhofer 1997). Accordingly, it is held that, taken as whole, this sequence presents a credible strategy for the description of spatiotemporal change.

In response to the second issue, wherein the absence of inventories or taxonomies was highlighted, it is held that this was beyond the scope of the present enquiry. Such an undertaking would demand a dedicated research project with a specialised focus. Accordingly, it is highlighted as an area for future research (see Section 7.8.1).

7.7.3 Limitations Relating to the Artefactual Contribution

In regard to the limitations relating to the enquiry's artefactual contribution, it should firstly be noted that, due to its specific focus on the arrangement of graphic content in graphic space in relation to the surrounding environment, there has been limited exploration of how the *interactivity* of the GPS-enabled WI might be designed. That is, an exploration of potentially viable interactive functions has not been pursued here. For example, approaches which might provide participants with the opportunity to select particular types of content, or allow them to vary the amount of content has not been pursued. Though no definite claims are made in regard to this area, it is the researcher's belief that offering users the opportunity to select particular types of content could enhance the potential for supporting exploratory wayfinding practices and reduce the distorting effects of interface-driven content (see Section 5.4.4.1, wherein concerns were raised in relation to the latter).

Further to the above, in a trade-off between the development of a working prototype and the refinement of its technical capabilities, it is also acknowledged that the interface's level of dynamism is limited. For example, participants were required to update the graphic representation through a button press, as this did not occur automatically through animated transitions. Again, it held that such a compromise was reasonable due to the enquiry's focus on the presentation of information for a relatively short period in time rather than a prolonged and multi-faceted interactive episode.

Finally, it is acknowledged that the design experiments and their results have arisen from a single designer's application of design practice, which in turn has resulted in a single case of information design being produced. As such, it cannot be seen as exhaustive. However, two points are offered in defence of this. Firstly, as Cross attests, *all* design solutions must necessarily be viewed as non-exhaustive in scope (2007:54). That is, no matter what level of development or refinement is achieved we must, as designers, accept that there is always the potential that these *may* be bettered. Secondly, throughout this enquiry, both in the framing of an area for experimentation, through to the iteration of the design, as well as in its final trialling, larger participant groups have been assembled (e.g. thirty-one participants took part in the semi-structured interviews and twenty-one in the prototype test). Assembling these relatively large groups has ensured that rich, diverse datasets were complied. In turn, this richness and diversity has ensured that the results were comprehensive to the point that saturation can be claimed (see Appendix B and Appendix D where saturation is dealt with). Thus, it is argued that as a practical response to how GPS-enabled WIS can be designed to support an urban recreational walker's/wanderer's situation awareness, the prototype interface holds a high degree of credibility.

With the enquiry's limitations discussed we will now, in the next section, highlight possible directions for future research.

7.8 Future Research

From the research contributions and limitations, areas for future research are identified. These relate to information design theory and to the design of GPS-enabled WIS.

7.8.1 Future Research Relating to Information Design Theory

Through the enfolding of an additional analytic level, i.e. the pragmatic, within Engelhardt's graphic syntax framework the dynamic and interactive aspects of graphic representations may now be enfolded within discussions of the syntax. From this, a variety of research paths present themselves.

Firstly, as has been highlighted in the limitations section above, there is an immediate need for the expanded framework to be applied to a wide array of dynamic and interactive graphic representations. Here, by developing a broader understanding of the dimensions of such representations, patterns may be identified. Were such patterns to be identified it would then be possible to formalise inventories for the proposed concepts of dynamic syntactic roles, dynamic meaningful spaces and dynamic expressions of information. From these inventories it would then be possible to move to develop taxonomies relating to types of dynamic and interactive graphic representations. In this way, Engelhardt's graphic syntax theory might be extended to cover not only the static, but also the dynamic and interactive language of graphics.

Another area for consideration is identified with regard to the introduction of the concept of a graphic representation having a physical/social context. While this has received some attention in the application of the extended framework to the prototype interface (i.e. the interface was assumed to have a physical context; see Section 6.3.2.3), there has been no exploration of how the notion of context might enter into analysis in a focused sense. Here, for instance the relationship between certain graphic representations and their environment might be looked at. In particular, it would seem that the relationship between environmental signage and internal (e.g. airports) as well as external settings (e.g. along roads) merits dedicated consideration. Here, studies could focus on the ways in which graphic relations *internal* to the graphic representation reference and involve *external* features in the environment, such as corridors, stairs, and junctions.

Beyond the above, other researchers might seek to frame their own personal extension of Engelhardt's graphic syntax framework with a view to better defining the scope of a possible additional analytic level.

7.8.2 Future Research Relating to GPS-enabled Wayfinding Interfaces to Visually Support an Urban Recreational Walker's/Wanderer's Situation Awareness

Leading directly on from this enquiry, there are several issues relating to the design of GPS-enabled WIs to visually support an urban recreational walker's/wanderer's SA-in-use, which might be further considered.

An immediate and obvious suggestion would be that alternative novel GPS-enabled WI designs to visually support a walker's/wanderer's SA-in-use be generated by other researchers, building on the work undertaken here. The availability of such WIs would further expand the frame of reference available to designers and might, in time, lead to the development of a potentially useful and robust information design pattern (Alexander et al. 1977) relating to the visual support of SA-in-use.

Beyond this, in direct relation to the artefact presented here, three information design issues in particular are seen to merit further attention.

First, as was noted in Chapter 5, some participants found the interface design as a whole under-resolved, while others found the pictorial representation of landmarks basic (see Section 5.4.4.3). Though these participants were in a minority, there is still much potential for the aesthetics of the interface to be explored further.

The second issue relates to the readability of the text within the design. Here a small number of participants either struggled to read the text as the interface rotated or else found the size too small (see Section 5.4.4.3). Thus, it was suggested that the text might be made to rotate with the interface (i.e. always remain level) and that more consideration might be given to the text size.

Then, lastly, the third and final issue relates to the amount of on screen content. Here, it would be desirable that specific numerical values might be identified in relation to an appropriate level of content, through a comprehensive test cycle.

In addition to the above, there is a clear need for future research to investigate the dynamic and interactive aspects of GPS-enabled WIS. As was noted in the limitations section (see Section 7.7.3), a number of potentially viable interactive options have not been attended to. Though it is not possible to set any restrictions here, it would appear that users would benefit from being afforded the opportunity to select particular *types* of content to be displayed, as well as to vary the amount of on screen information. From the perspective of the interface's dynamic aspects, as is commonly suggested in presentations of cartographic research agendas (e.g. MacEachren 1995), the animated transitions between particular states of representation requires dedicated and prolonged study.

Then, from a methodological perspective, it is here suggested that this enquiry's claims in relation to the design of GPS-enabled WIS should be looked at longitudinally such that their long-term viability may be assessed. Alternatively, the results that were arrived at in this enquiry might be retested with a view to further refining both the design and its associated contextualised graphic syntax. As such, the warranted assertability (Dewey 1986/1938:18) of this enquiry might be rightly trialled.

Summary

This chapter has concluded the thesis by providing an overview of the enquiry, its contributions and limitations, alongside setting out possible directions for future research. It was comprised of eight sections. The first section offered a brief reflection upon the enquiry as a whole. Then, in the second, third, fourth and fifth sections a summary of the enquiry's methods, as well as the results that have been obtained, was provided. From this, in the sixth section, an overview of the enquiry's contributions to knowledge was set out. These were said to be threefold. The first is a GPS-enabled WI design, i.e. an artefact, which has been shown to support SA-in-use. The second, arising from the first, is a contextualised graphic syntax for design (Engelhardt 2002; Zimmerman et al. 2010; see Section 3.1.2). In setting out a series of principles, this graphic syntax provides an outline for the design of a GPS-enabled WI to visually support a walker's/wanderer's situation awareness in use. Third, and finally, an extension of Engelhardt's graphic syntax framework (2002) to include an additional analytic level (i.e. the pragmatic) was proposed. By expanding the framework's scope, the description of the dynamic and interactive aspects of graphic representations is now made possible.

From this, the seventh section addressed the enquiry's limitations. These were seen to relate to both the methodological and practical aspects of the enquiry. Finally, in the eighth section a number of possible directions for future research, pertaining both to information design theory and practice were highlighted.

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Glossary

Behaviour

Here, seen to refer to the way an individual acts based on observation of their movements and/or gestures.

Embodied Involvement

The body's inevitable situatedness within a spatiotemporal flow [Section 2.3.1].

Experience

A person's contact with and/or conceptualisation of particularities, either physical or temporal.

Exploratory Wayfinding

An embodied process wherein the walker observes, experiences and affects/is affected by environmental and/or social conditions as they link together and comprehend a series of seen vistas in a given, possibly unfamiliar environment, such that there is no fixed plan or route [Section 2.3.2.1].

Graphic Object

An elemental or composite *component part* of a graphic representation, e.g. a shape or a piece of text [Section 2.1.5].

Graphic Space

The space of a graphic object, which may or may not contain other graphic objects [Section 2.1.5].

Graphic Syntax

The structuring of a graphic representation, wherein the representation is seen as a graphic object containing other graphic objects which are all involved in set of graphic relations [Section 2.1.5].

GPS-Enabled Wayfinding Interface

A digital map or digital mapping product, with GPS-capability, appearing on a handheld mobile device which, through interaction, provides the user with a representation of their geographic position and, additionally, may support navigation.

Graphic Representation

Here, we follow Yuri Engelhardt's definition: 'a visible artefact on a more or less flat surface, that was created in order to express information' (Engelhardt 2002:2).

Information Design

The practice of systematically developing and arranging graphic content within a graphic space to produce graphic representations for particular platforms or environments, such that the needs of a given audience are met [Section 2.1.1].

Interface-Environment Interactions

A user's observed distribution of attention between a digital interface and the surrounding environment [Section 2.3.6].

Participant

A person who has voluntarily agreed to take part in, and contribute to the research process and outcome.

Possible-Use

A *proposed application* that a participant ascribes to the prototype interface [Section 5.4.4.4].

Phenomenology

A philosophy, originating in early twentieth century Europe, concerned with how things appear to be, to someone [Section 2.3.1].

Practice-Based Research

A form of research which foregrounds practice within the research process (Candy 2006). This is here seen as synonymous with the 'research *through* design' approach (Frayling 1993; italics added) [Section 3.1.1 and Preface].

Pragmatism

A philosophy, originating in early-twentieth century America, which places emphasis on the practical application and testing of concepts and theories in order that their value might be assessed [Section 3.1.3].

Pragmatics

An area of semiotics (i.e. the study of signs) concerned with the study of the use of signs in context [Section 2.1.4 describes how this is approached in analytic frameworks relating to graphic representations].

Semantics

An area of semiotics (i.e. the study of signs) concerned with the study of the meaning of signs [Section 2.1.4 describes how this is approached in analytic frameworks relating to graphic representations].

Semiotics

The study of signs and their use and interpretation [Section 2.1.1 outlines how semiotics is enfolded within information design theory].

Situation

A person's embodied involvement in the surrounding environment [Section 2.3.1].

Situation Awareness

A person's awareness of their embodied involvement in the surrounding environment [Section 2.3.7].

Situation Awareness in Use

A person's awareness of their embodied involvement in the surrounding environment within their use of technology [Section 2.3.7].

Syntactics

An area of semiotics (i.e. the study of signs) concerned with the study of the sign structure [Section 2.1.4 describes how this is approached in analytic frameworks relating to graphic representations].

Syntactic Role

The *meaningful* anchoring of a graphic object either *in* graphic space and/or *to* another graphic object [Section 2.1.5.1.1].

Viewer

A person who is looking at a graphic representation.

Wandering

An embodied process wherein a person walks with no fixed plan or route through a given, possibly unfamiliar, environment [Section 2.2.2].

Wayfinding

An embodied process wherein embodied perception and embodied knowledge allows a walker to link together and comprehend a series of seen vistas along a route through a given, possibly unfamiliar, environment [Section 2.3.2].

Urban Recreational Walking

An embodied process wherein a walker moves through a given, possibly unfamiliar, urban environment; and therein observes, experiences and affects/is affected by environmental and/or social conditions.

User

A person who is interacting with a designed artefact.

Appendix A
The Interview Guide

This appendix documents the interview guide applied within the programme of semi-structured interviews in the enquiry's first phase (see Chapter 4).

1. How often do you 'go for a walk' in an urban setting?
2. Generally, what motivates you to do so?
3. How much attention would you say you pay to the features of route you travel along?
4. Are the locations you visit mostly familiar or unfamiliar?
5. What would inspire you to take an unfamiliar route?
6. Before deciding to take an unfamiliar route, is there any particular information you feel you would need to know?
7. Is there anything that you feel would hold you back?
8. Have you ever walked through an unfamiliar location without a fixed plan or route in mind?
9. If yes, can you please describe the experience?
10. When you are in an unfamiliar location what resources do you usually draw on in order to find your way as you walk?
11. Thinking specifically of (city) maps, what features do you find most useful as you walk?
12. Do you find any map-features particularly useful when trying to stick to a general direction?
13. Could you please describe how you make use of these map features?
14. Do you, or have you ever, used a map on a mobile phone to find your way while walking in an urban setting?
15. If yes, can you please describe how you use them?
16. If yes, can you please describe the positive and negative aspects of the experience?
17. Considering the design of a 'standard' map, whether paper or digital, how do you think it could be improved?

18. Finally, do you feel your use of a map, whether paper or digital, affects your impression of the environment?

Appendix B Demonstrating Saturation in Semi-Structured Interview Data in Phase One

This appendix provides a demonstration of saturation within the semi-structured interview data from phase one (i.e. in the programme of semi-structured interviews with walkers/wanderers). In order to provide this demonstration, figure B.1, on the pull out overleaf, maps the basic themes that were seen to emerge in the data obtained in response to the second and sixteenth questions (see Appendix A for the full interview guide). This data was pivotal in the process of framing an area for experimentation, which in turn allowed for the formulation of a design hypothesis. Herein, participants were asked, respectively, about their motivations to engage in urban recreational walking/wandering and the positives and deficits of GPS-enabled WI use (see Section 4.2.1 and 4.2.6 respectively). Thus, the mapping lists the numbers of the participants along the centre and, in turn, links them to both the motivational themes along the top and the deficit-based themes along the bottom.

It will be noted that the themes are presented in chronological order. Accordingly, if we study the lines linking the themes with the participants we can identify the points at which a theme was seen to emerge within the sequence of the programme.

In doing so, we find:

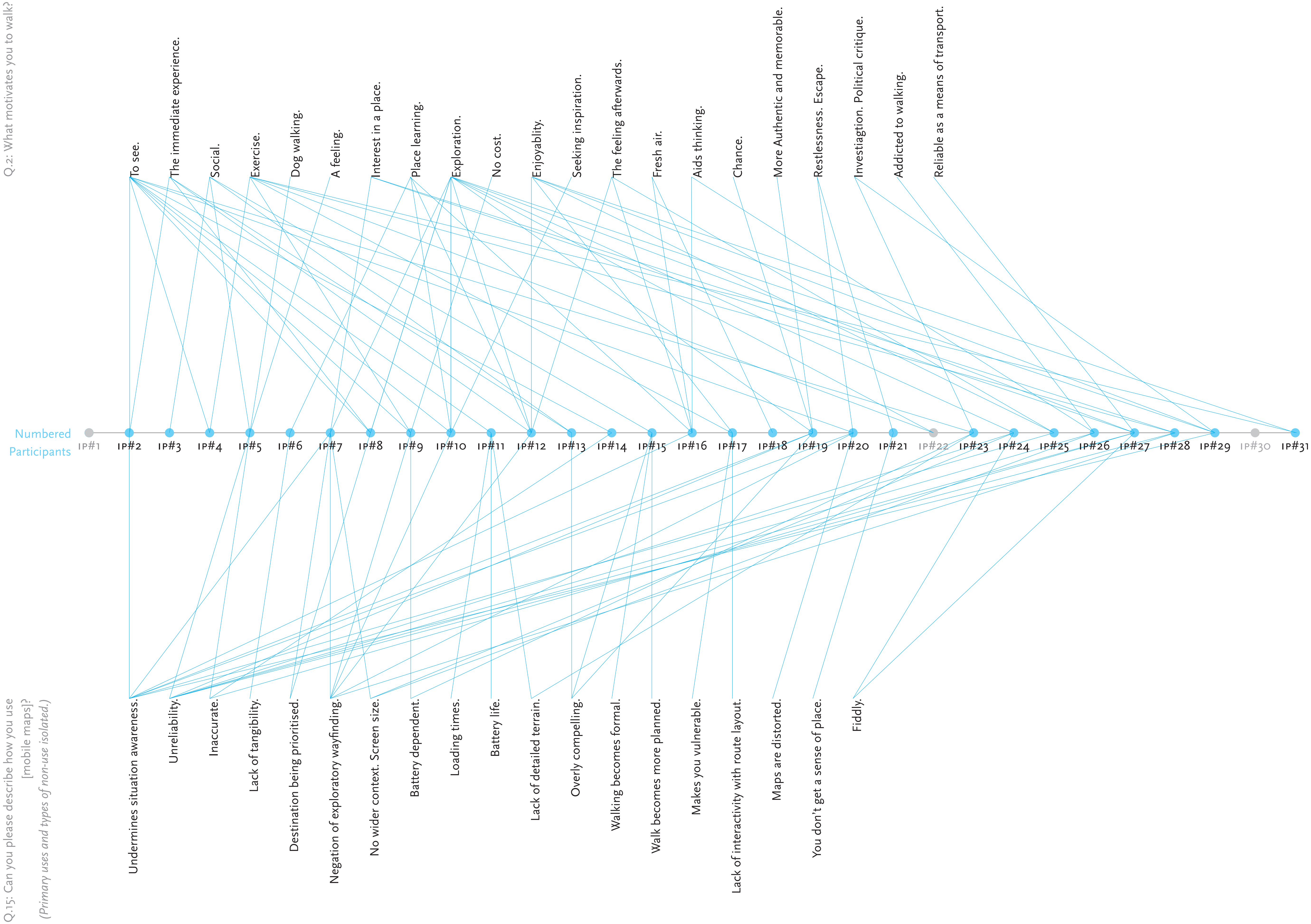
- The most prominent motivational theme, *exploration*, is first linked to IP#7;
- The most prominent deficit theme, *undermines situation awareness*, is first linked to IP#2;
- The last significant motivational theme (i.e. theme associated more than three participants), *enjoyability*, is first linked to IP#12;

- The last significant deficit theme (i.e. theme associated more than three participants), the *negation of exploratory wayfinding*, is first linked to IP#7.

Based on the above, it would seem that the key themes emerged early, and the last significant theme emerged before the mid-way point in the programme of interviews. Thereafter, only insignificant themes, i.e. themes which relate to three or less participants, are seen to emerge.

Thus, having demonstrated the diminishing rate at which themes were yielded in relation to these two key responses, it is seen as reasonable to assert that saturation was achieved within the semi-structured interview data of phase one.

Figure B.1 The Themes Relating to Participants’s Motivatations to Walk/Wander and their Priority Uses Set Out Chronologically



Appendix C
A Diary of the Design of the Final Prototype

This appendix documents the process of designing the final prototype. It is presented, as it was originally written, in a diary-format. Here, each entry is dated and the particular focus of the design activity identified. These entries tend to act as a log of the questions that were posed within practice. Alongside each, images of work-in-progress are presented.

C.1 Exercise Focus: Pictorial Representations for Landmarks for the Working Prototype 21/6/14

This exercise progressed through the sketching out of possible approaches to landmark representation, with particular landmarks being considered, one-by-one, on a stand-alone basis. At various points, as issues were encountered, it was necessary to pose questions. For example, while attempting to gauge one building's dimensions it was necessary to ask a question along the lines of:

> How might I develop a way of representing landmarks, which remains faithful to their basic proportions?

Such questions were seen to initiate a dedicated series of sketches, which may be said to have acted as layered explorations of possible solutions. Held together, these explorations provide us with an array of, more or less resolved, conceptual responses. Below, we find a list of these questions linked to their respective conceptual responses. Beyond these, several reflections/discoveries are noted.

Q: How can you maintain/attend to the proportions of the buildings/landmarks being represented, without requiring plan drawings?

R: Develop a series of proportionally referenced grids into which the basic shapes of these building can be fit. For example, a 1:2 grid might frame the Glasgow University tower. A 2:3 grid might frame the outdoor theatre. Beyond this, the significant features of the landmark might be identified and iterated to a satisfactory level of refinement.

Q: Is it possible to represent a building based on only a part of its structure, e.g. the towers of the Kelvingrove Museum?
R: Having tested this through sketching it appears as though this may be possible but it is likely that the particular detail highlighted would have to hold, what Lynch (1960) might refer to as, a high 'imageablity' (see Section 2.3.2).

Q: Is identifying a minimal number of shapes required to represent a landmark a viable approach to designing a pictorial representation for that same landmark?
R: It would appear that identifying a minimal number of shapes required to represent a landmark is a viable approach to designing a pictorial representation for that same landmark. Starting with a profile shape and rapidly scaling upwards allows for the identification of what would appear to be a minimal/desirable threshold of shapes.

Reflection: Landmarks should be shown in profile as much as possible. Perhaps when they are close by. This approach will be taken, on the basis that Gibson's theory of vision (1986/1979) emphasises our embodied, visual link to the environment in wayfinding. However, landmarks such as a bridge or a river would appear better suited to being represented in plan. It would seem that this is because they are conceived of as essentially linear in structure.

Reflection/Discovery: It would appear that allowing landmark representations to extend beyond their 'containing' triangle might be an appealing approach to take.

Reflection/Discovery: The possibility of giving every profile landmark a 'platform line' on which to sit might be a helpful feature. Furthermore, this 'platform' line might, on occasion, be transformed into a v shape and here applied as a means of representing sections of a building.

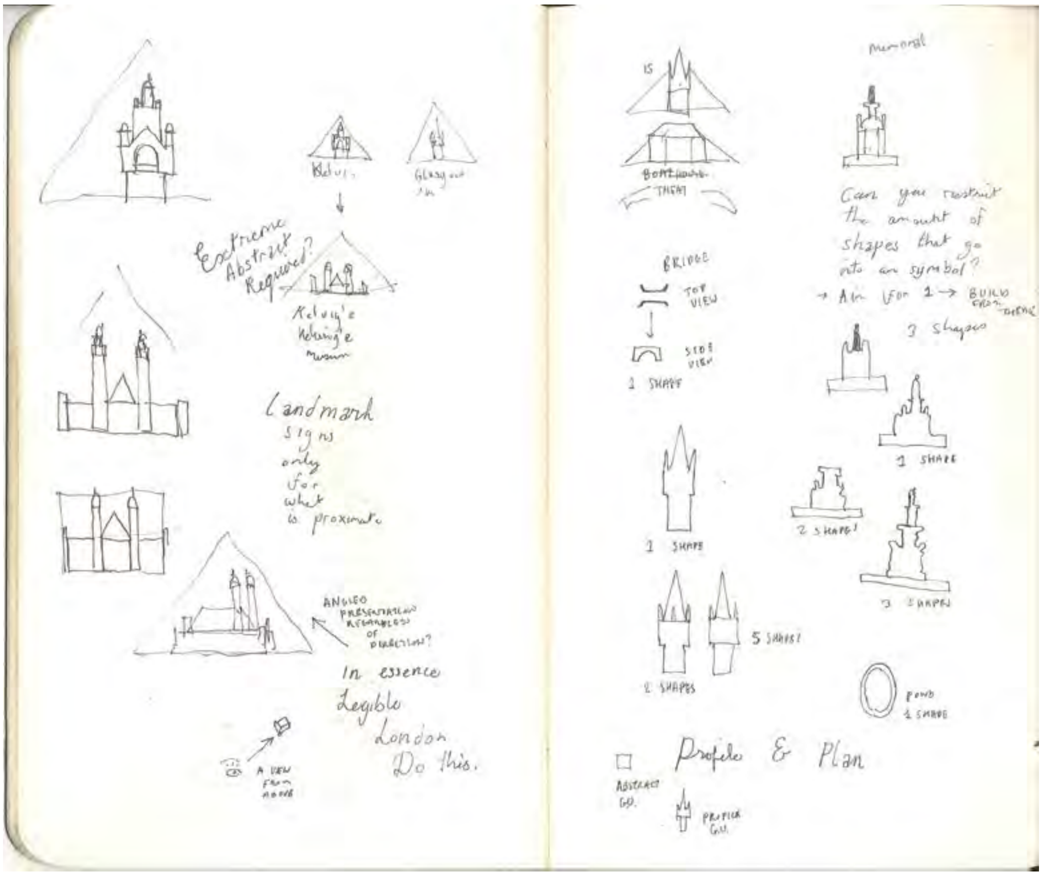


Fig. c.1 A double sketchbook page from the first session looking at the design of landmarks for the final prototype. On the left hand page we see a variety of attempts to sketch out a pictorial representation for Kelvingrove Museum. On the right hand page we see a number of sketches of the Glasgow University clock tower and the Stewart Memorial fountain.

c.2 Exercise Focus: Pictorial Representations for Landmarks for the Working Prototype 22/6/14

As above, this exercise progressed based on sketching possible approaches to particular landmark representations. Explorations were somewhat more limited than before. Below the questions and the conceptual responses are again listed, along with reflections underneath:

Q: If only part of a building may be seen, as in the example of Hillhead school then it would seem that it might not be a good idea to attempt to design a fully visible profile.
R: This may be the case but it needs to be explored further.

Q: Further to the above, might it be best to apply a highly simplistic representational style to such landmarks? For example, a rectangle?

R: It might, this will need to be explored.

Q: Might the pictorial representations be designed in an impressionist manner, i.e. giving a sense of the building's shape? Doing so would bypass concerns regarding realism, and faithfulness. Not perfect, but recognisable, would be the mantra here.
R: Yes, it might, but this needs to be explored further.

Reflection: Participants' reactions to the profile-based landmarks could be tested in their account of experiencing the prototype interface.

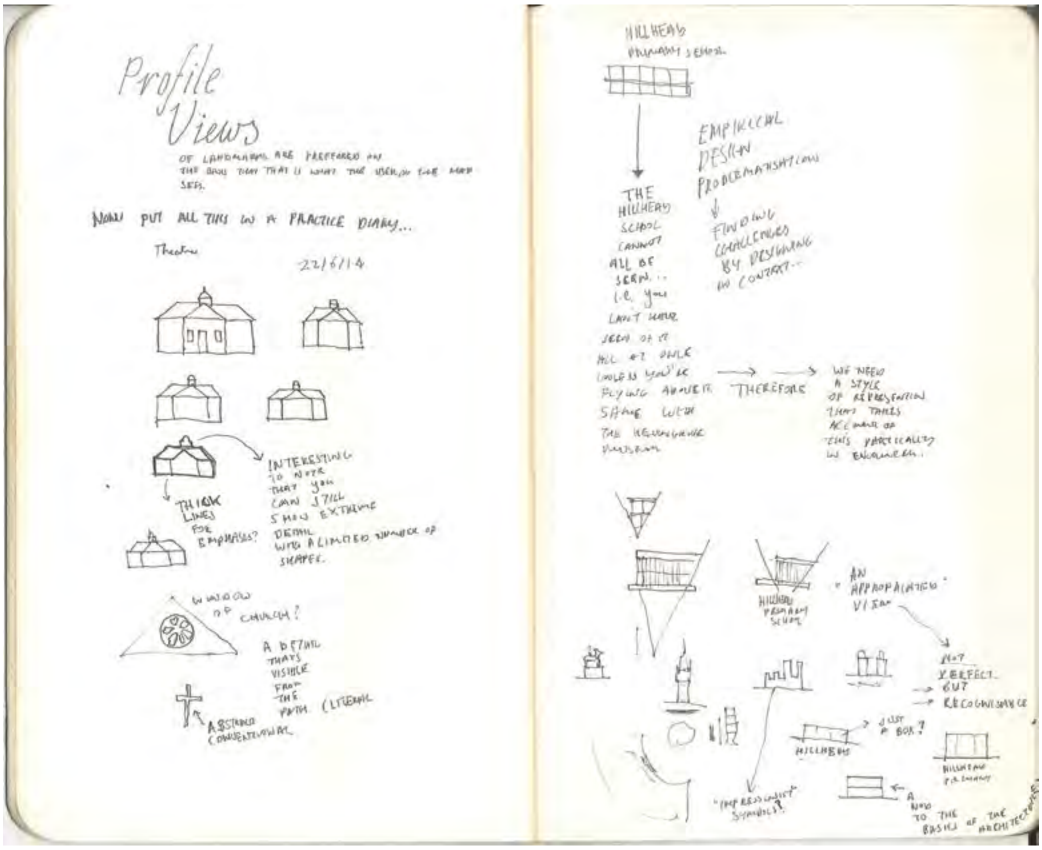


Fig. C.2 A double sketchbook page from the second session looking at the design of landmarks for the final prototype. On the left page, the sketches of the theatre record an attempt to incrementally reduce the number of elements within the representation in order to test for a threshold at which it appears to lose clarity. On the right hand page, a note is made of how, when landmarks are only partially visible, faithful representation becomes challenging.

C.3 Exercise Focus: Making Digital Pictorial Representations for Landmarks for the Working Prototype 23/6/14

Here as a next step, the designs moved onto the computer. A basic grid was decided upon where 320px was seen as the screen radius and from this segments of 32px where taken as basic units with which to begin drawing the pictorial representations. (These measurements were derived from the iPhone 4s's screen dimensions; see Section 5.1.1). Three pictorial representations, focusing on what felt like the most straightforward items where attended to. These were: the Glasgow University tower; the Stewart Memorial; and the church at the end of the route. Several screen shots were taken so as to record the design's progress.

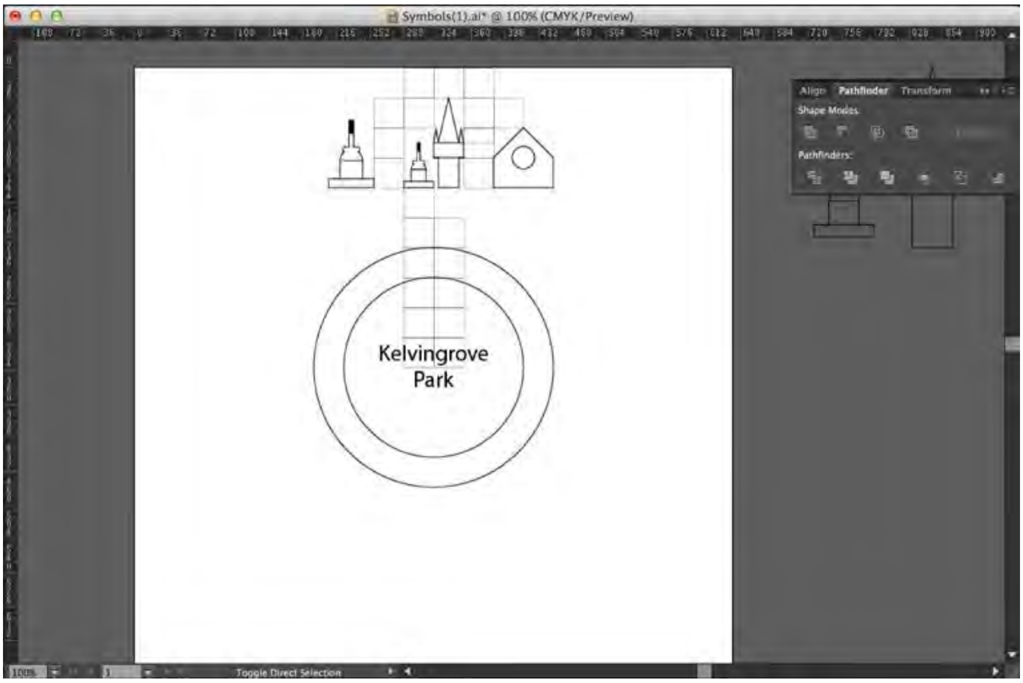


Fig. C.3 The first digital artwork, wherein three separate pictorial representations were designed: the Stewart Memorial, the Glasgow University clock tower and St. Silas Church.

C.4 Exercise Focus: Making Digital Pictorial Representations for Landmarks for the Working Prototype 28/6/14

Continuing the work undertaken above, the design of other pictorial representations was progressed. As a first step some revisions were made to the Stewart Memorial pictorial representation. Here, the shape of the 'person' on top was changed from a rectangle to an ellipse. On viewing the pictorial representation at a distance from the screen this adjustment appeared to result in a more organic, human shape.

Four further pictorial representations were produced. These were: the outdoor theatre building; the Hillhead school; the Robertson Memorial; and the Kelvingrove Museum. Of these, the most pressing questions arose in relation to the Robertson Memorial and the Kelvingrove Museum, as outlined below:

Q: How can the horse be drawn in such a way as it looks natural but still hold to a basic measured grid?

A: After much playing around with ellipses and seeking to produce a horse shape out of these, a solution was arrived at in the form of overlapping basic triangular shapes. With careful attention to proportion the horse shape was devised through a number of minimal adjustments, and evaluations of these adjustments. It would therefore appear as if simple organic shapes can be composed on the basis of playful triangular and circular/elliptical arrangements.

Fig. C.4 The Robertson Memorial pictorial representation. Note that the horse is comprised of triangles, which, though simple, are seen to suggest a horse shape.

Q: How can the Kelvingrove Museum be represented in such a way as a pictorial representation of the whole building is avoided; yet a sense of unity is preserved?

A: The challenge of not representing the whole of the Kelvingrove Museum arose out of the fact there appears to be no one point at which the whole building may be seen in its entirety, at least not from the eastern side of the river, i.e. the test-route location. Seeking an environmentally grounded pictorial representation, the design challenge then is to represent the museum on the basis of an aspect or key feature of its architecture. After some brief sketches it was decided that the towers appeared to provide such a feature. The concept of including a line or group of lines so as to represent an occluding edge (which had arisen in earlier work; see Section C.1 above) was recalled and subsequently applied in the eventual pictorial representation. On first viewing, this approach was judged to be highly effective. As a result, it was then also applied to the first pictorial representation that had been developed, the Glasgow University tower.

Fig. C.5 The Kelvingrove Museum pictorial representation with a V-shaped edging at the bottom. This edging is included so as to suggest that the image represents a detail as opposed to the entirety of the building.

Reflection: By testing the design on the phone for the first time it was noted that the line-weight, i.e. the stroke was too light. It was therefore doubled. This doubling was then tested and the results were deemed satisfactory. Also considered was increasing the size of the pictorial representations to 150% of their size. On testing this, the increase was deemed unnecessary.

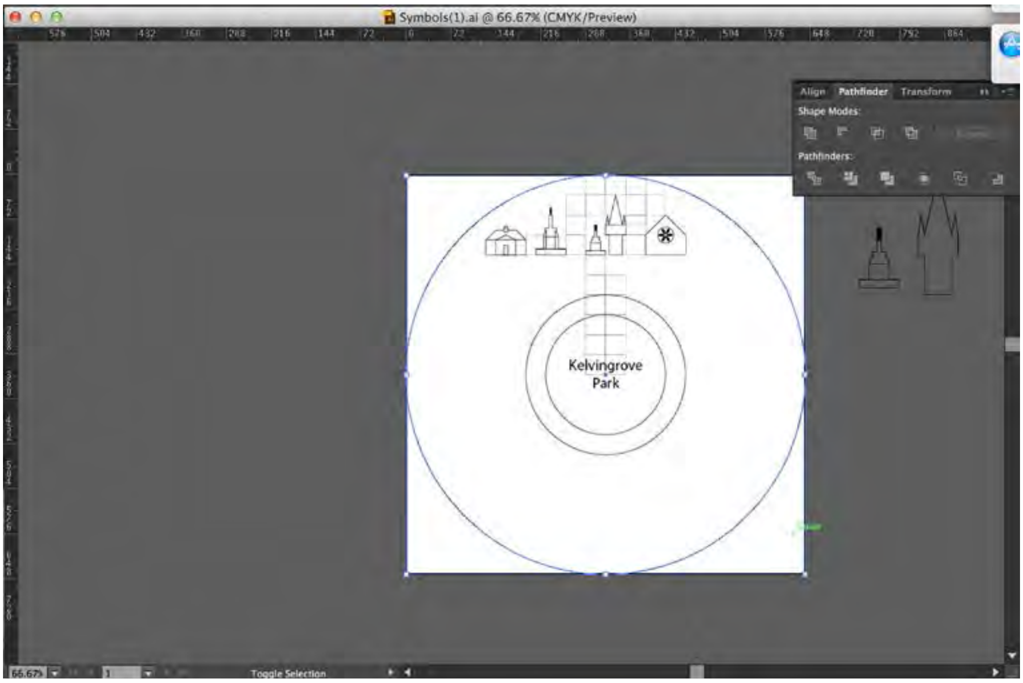


Fig. c.6 The digital artwork continues. We see that an additional pictorial representation has been designed: the outdoor theatre.

c.5 Exercise Focus: Designing the Unique Images/WIs 29/6/14

This exercise focused on the design of the first unique images/WIs. (For an outline of how data was collected to populate these images/WIs, please turn to Section 5.4.1).

To begin, the representation of the river, and its positioning was taken as a starting point. This allowed the graphic space as a whole to be properly considered. It became clear that it would be necessary to develop particular rules relating to particular graphic objects and their positioning. The following list gathers together some of the problems and solutions, questions and answers that were dealt with through the exercise.

Q: How do you show a city 'district'?

A: Based on earlier work undertaken in the field simulation test, it was decided that districts would be represented through a 22.5 degree arc (one eight of a circle) containing text and a triangle. In order to emphasis distance the triangle was placed at the edge of the segment.

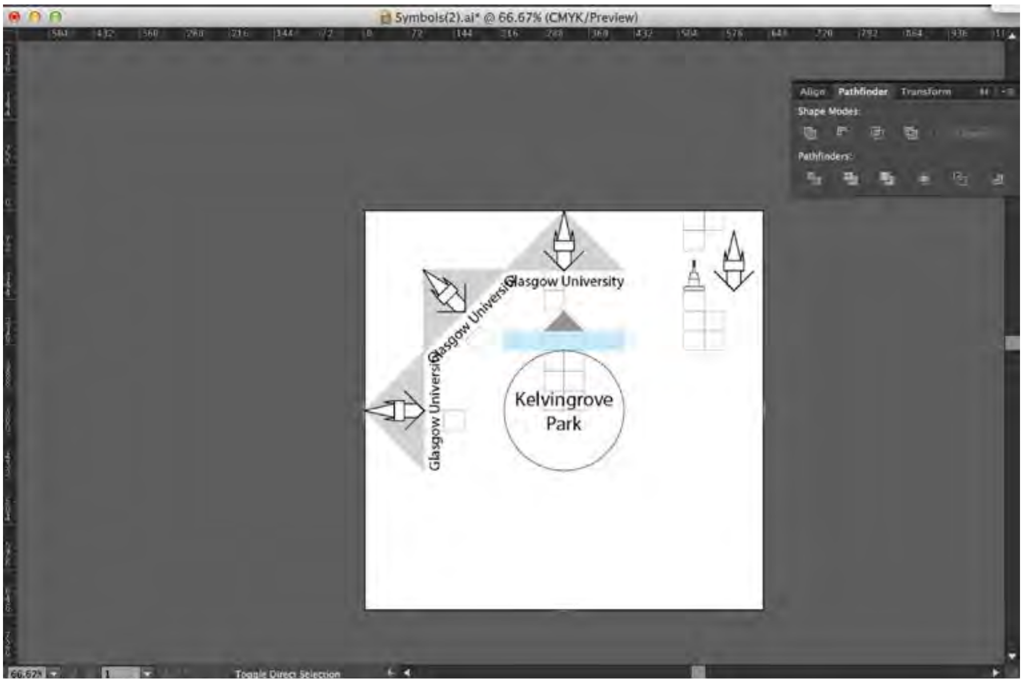


Fig. c.7 The digital artwork continues, as the larger landmark representation (i.e. the pictorial representation in the grey triangle) is designed. The blue line above the centre circle marks a first iteration of what eventually became the representation of the river. Here, close attention was being paid to the amount of space available between the centre circle and the outer representations of landmarks.

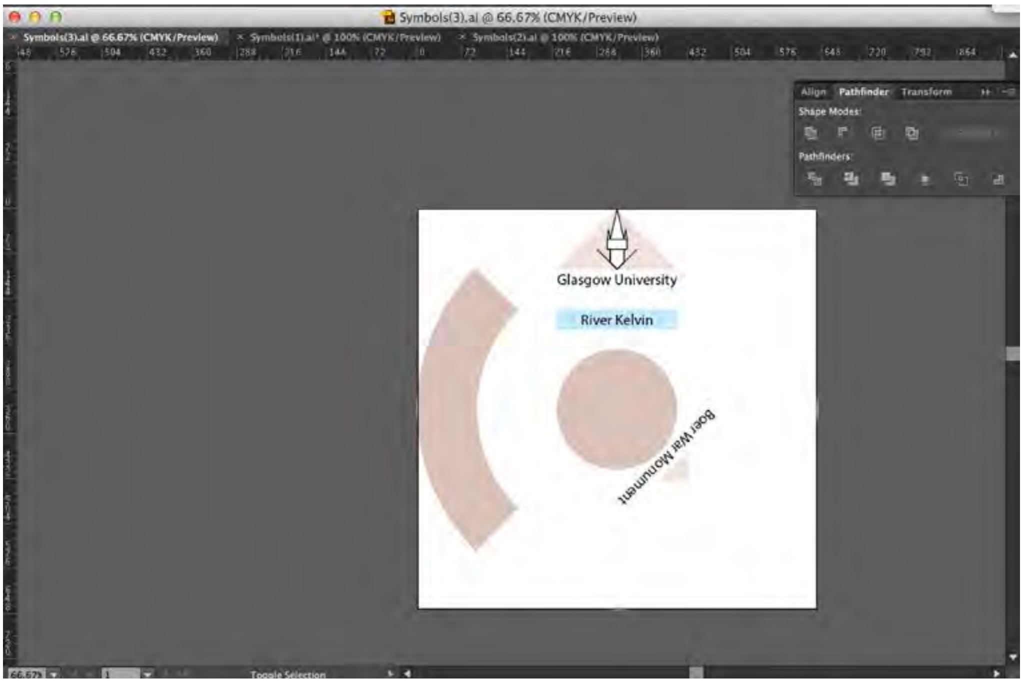


Fig. c.8 The digital artwork continues. Colours are selected. The thick arc to the left marks a first attempt at designing a representation of a district, i.e. a graphic object that directs a user to an area/district. Additionally, the smaller triangle with text is a first attempt to represent proximate features.

Q: How can 'near features' be placed in order that they be differentiated from 'far features'?
A: This question required extensive attention. Several representations required different approaches. The first 'near feature' was the pond. Here, the small triangle, and the circular feature containing text was seen to offer the most simple and effective solution. This was soon followed by the Stewart Memorial. Due to the height of this representation, it was found to overlap with the shape above it. However this did not seem to interfere with the representation's legibility.

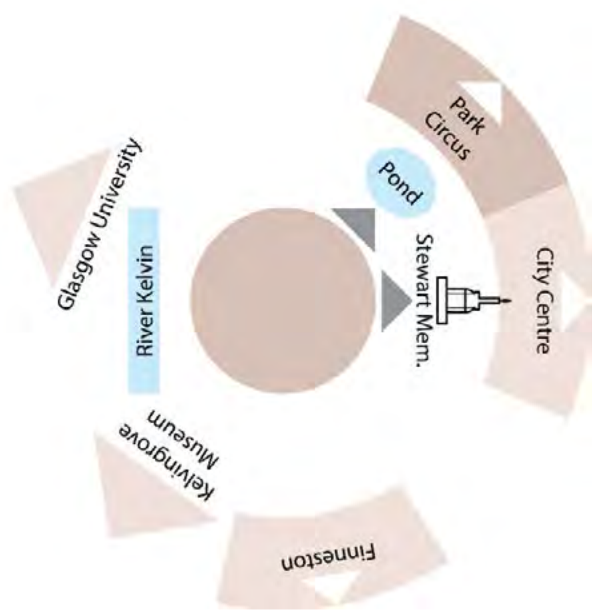


Fig. c.9 On the right we see the Stewart Memorial pictorial representation overlapping with the shape near. It was decided that this approach, whereby objects may overlap, did not hamper legibility

Beyond this, one particularly challenging instance of a near-here representation arose when the object representing the theatre was being positioned. This was due to the fact that two other objects needed to be placed next to it, with one in front and the other behind. These objects represented the river Kelvin and Glasgow University respectively. In prior instances the Glasgow University pictorial representation had appeared as a large triangle. This would not fit in the space. As such, it was decided that the best approach would be to reduce the size of the Glasgow University triangle and remove the triangle underneath the pictorial representation of the theatre, thus freeing up a significant amount of graphic space overall. This approach appeared to be successful.

In this way, a grouping of representational techniques with which to indicate near-here and far features was developed.

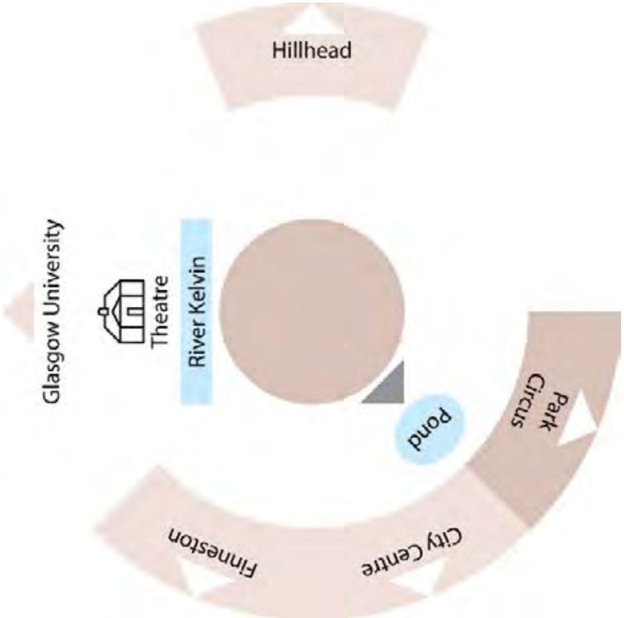


Fig. c.10 On the left we see the eventual arrangement of the smaller triangle for Glasgow University and the near features of the theatre and the river.

c.6 Exercise Focus: Walking with the Prototype in-Situ for the First Time 30/6/14

In using the prototype for the first time a north-south course was taken. Within each test-route section, the unique image/w1 was drawn down repeatedly in order to identify the point that a transition would take place. Furthermore the pictorial representations within the interface were checked against the features of the environment. Points of friction were noted. This included times when features were misaligned, when particular representations were appearing too quickly, and when these representations lasted too long, i.e. did not properly represent the transition that the walker was likely to experience.

Through this process, it was noted how the appearance of pictorial representations for visible landmarks were quite successful. It was felt however that a greater distinction needed to be made in relation to 'far features'. Here, when visible, these features were appearing as large triangles with pictorial representations contained within, as was the case for the Kelvingrove Museum and Glasgow University. When invisible, the pictorial representations were removed but the large triangles remained. The one exception to this was when the theatre appeared. As was noted above, space limitations required that the Glasgow University triangle above be reduced in size. This minimising appeared to be more helpful than the larger, empty triangles. As a result it was decided that the smaller triangle should be applied to all similar instances across the other images/WIs.

Finally, two major issues were identified in relation to the dynamic and interactive. Firstly, it was noted that directly refreshing the page (i.e. pressing the refresh button on the top right) in order to draw down a new image/WI was not satisfactory. Secondly, the rotation of the image/WI on screen was causing the image to transform in size (i.e. get bigger and smaller as it rotated), and was thus interfering in the viewing experience. Both of these issues were subsequently resolved.

C.7 Exercise Focus: Walking with the Prototype in-Situ for the Second Time 3/7/14

This walk was successful in that most of the objects were found to be in alignment with the features of the environment.

It is however worth highlighting a realisation, which occurred to me as I walked towards the test-route and saw Glasgow University tower in the distance. Here, it became clear that no matter what algorithmic code was applied to whatever set of geocoded landmarks, it would not be possible to *anticipate* through code alone, when a landmark would appear in view for a participant and when it would recede once again.

C.8 Immediate Reflections on Launching the Prototype Test 10/7/14

Commencing the prototype test cycle, I met with the first participant in the morning at the southern end of the test-route.

After their Google Maps task, they were handed the prototype. By way of instruction, they were told to follow the river as far as 'Gibson Street' where 'there were coffee shops' and to check the phone at least twice during their journey. As they set off, I sat and watched from the starting point. Within a distance of about twenty metres, the participant checked the device, pausing for a moment and looking around. I continued to sit until they turned a corner ahead and at this point began to follow. Here, I made an express effort to maintain an extended distance between the two of us.

Meeting the participant at the end of the test-route, I found that they were standing waiting not far from the bridge at Gibson street. Immediately, the participant launched into conversation unprompted. They noted how being provided with the names of environmental features had a surprising and positive effect on their experience. They also noted how they felt the design of the features held an 'immediate' relationship with that which was being represented. They also commented on how the exclusion of streets and roads allowed them to 'relax'; direction and a time were also considered helpful too. Further, they went so far as to highlight the features, which they felt should be included in the interface. For example, they were surprised that a particular statue was absent.

I noticed that when I asked them formal questions, their answers at once became more formal and constrained. As such, it would appear preferable to let the participant speak openly at first and then address questions afterwards.

Appendix D Demonstrating Saturation in the Semi-Structured Interview Data in Phase Two

This appendix provides a demonstration of saturation within the semi-structured interview data in phase two. In order to provide this demonstration, figure D.1, on the pull-out overleaf, maps the basic themes that were seen to emerge in the data obtained in response to the second question (see Section 5.4.4 for the full list of questions). Here, participants were asked to relate their *experience of* the prototype and Google Maps (i.e. to discuss what each was *like* to use; see Section 5.4.4.2). It was intended that data collected here would be integrated with the *quantitative* data collected through observation (see Section 3.3.9), which would then allow for participants' SA-in-use to be assessed (see Section 6.1). Thus, the mapping lists the numbers of the participants along the centre and, in turn, links them to the themes which emerged in relation to participants' *experiences of* the prototype along the top and their *experiences of* Google Maps along the bottom.

It will be noted that the themes are presented in chronological order. Accordingly, if we study the lines linking the themes with the participants we can identify the points at which a theme was seen to emerge within the sequence of the programme.

In doing so, we find:

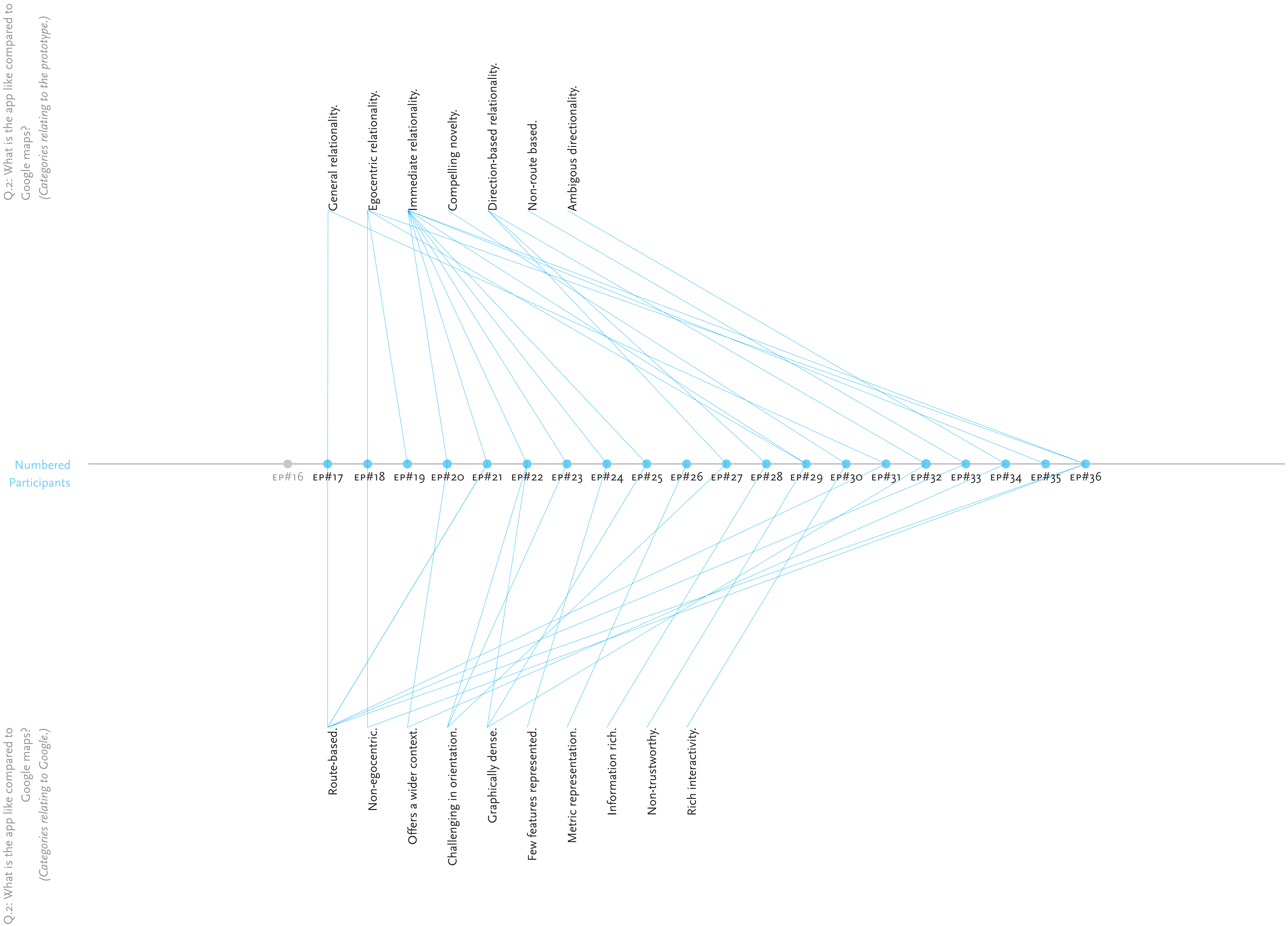
- The most prominent theme to emerge in relation to the prototype, *immediate relationality*, is first linked to EP#20 (i.e. the fourth interview);
- The most prominent theme to emerge in relation to Google Maps, *route-based*, is first linked to EP#17 (i.e. the second interview);

- The last prominent theme to emerge in relation to the prototype, (i.e. a theme associated with more than three participants) is also *immediate relationality*, first linked to EP#20 (i.e. the fourth interview);
- The last prominent theme to emerge in relation to Google Maps, *graphically dense*, is first linked to EP#22 (i.e. the sixth interview).

Based on the above, it would seem that the key themes emerged early, and the last significant theme emerged before the mid-way point in the programme of interviews. Thereafter, only insignificant themes, i.e. themes which relate to three or less participants, are seen to emerge.

Thus, having demonstrated the diminishing rate at which themes were yielded in relation to these two key responses, it is seen as reasonable to assert that saturation was achieved within the semi-structured interview data of phase two.

Figure D.1 The Themes Relating to Participants' Experience of Google Maps and the Prototype Set Out Chronologically



Appendix E The Visualisation and Qualitization of Participants' Interface-Environment Interactions in the Prototype Test

This appendix contains three sections. The first section documents a set of diagrams, which were produced in order to visualise participants' behaviour in their use of Google Maps and the prototype in the prototype test (see Section 5.4.5). In each, two behaviours are attended to: the *frequency* of participants' upward glances/gazes and the *duration* of these upward glances/gazes.

The second section presents adapted versions of these diagrams, which were produced in order to enable the *qualitization* of quantitative data (see Sections 3.3.8.3 and 5.4.5.1). This process of qualitization took place in order to enable the *integration* of qualitative and quantitative data in the final prototype test (see Section 6.1).

The third and final section presents a series of tables setting out the results of this process of qualitization.

E.1 Participants' Use of Google Maps and the Prototype Compared in Diagrams

As may be noted below, each participants' sample of their use of Google Maps and the prototype is represented by a line plotted along an x-y axis. By varying the direction of this line, each graph shows the points at which the participant looked *up* at the environment or *down* at the screen, as well as the duration for which they did so.

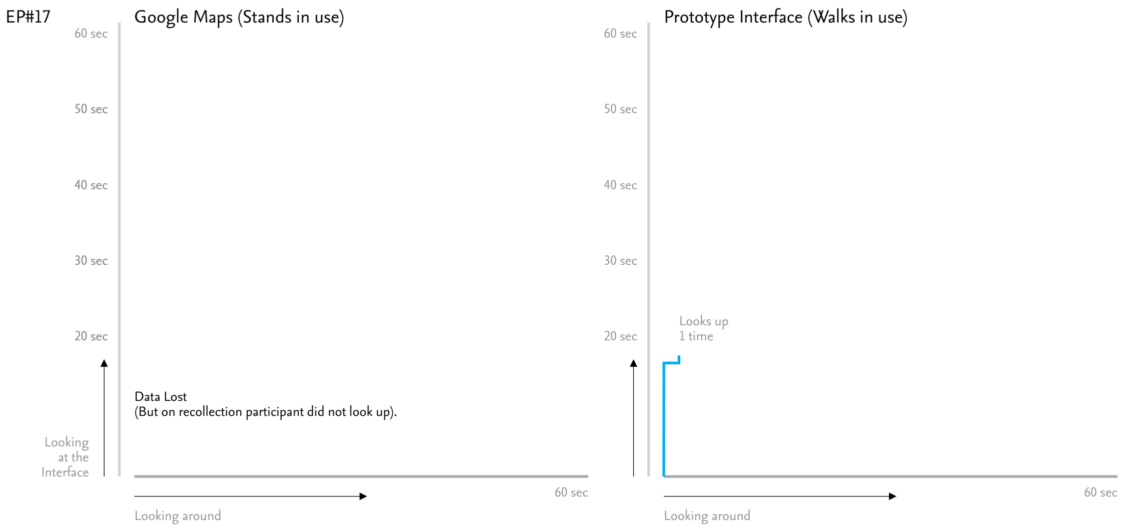


Fig. E.1 EP#17's results.

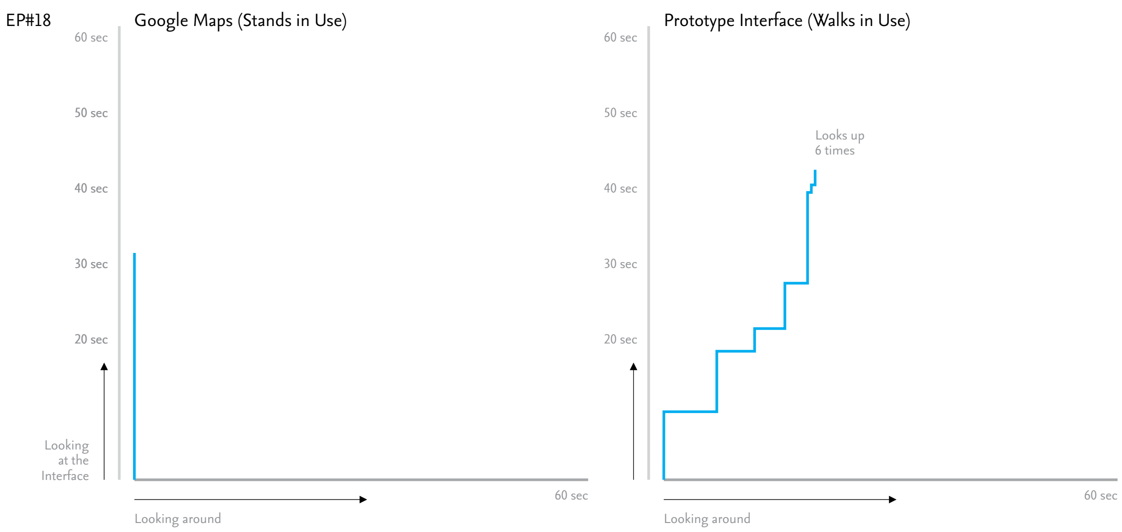


Fig. E.2 EP#18's results.

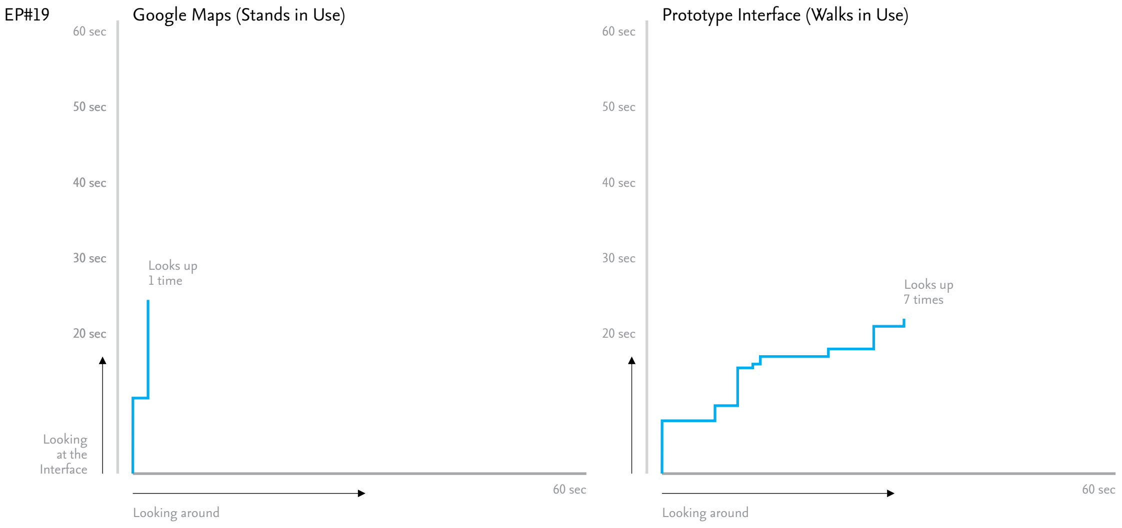


Fig. E.3 EP#19's results.

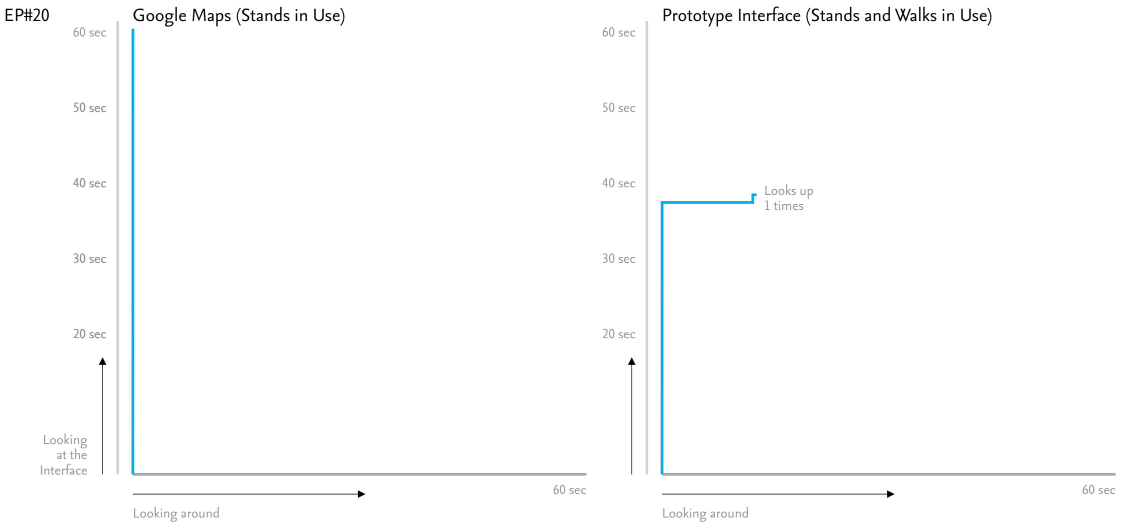


Fig. E.4 EP#20's results.

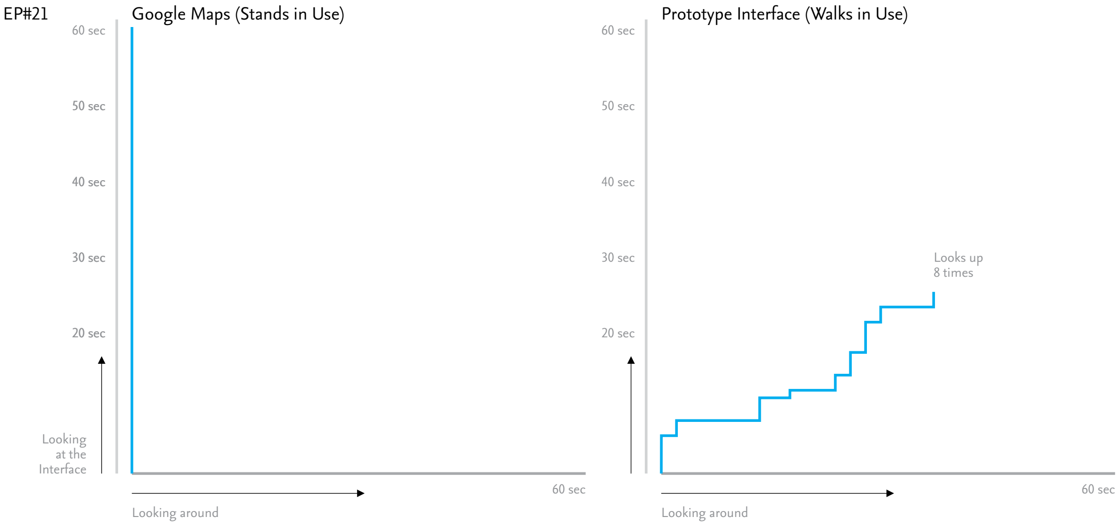


Fig. E.5 EP#21's results.

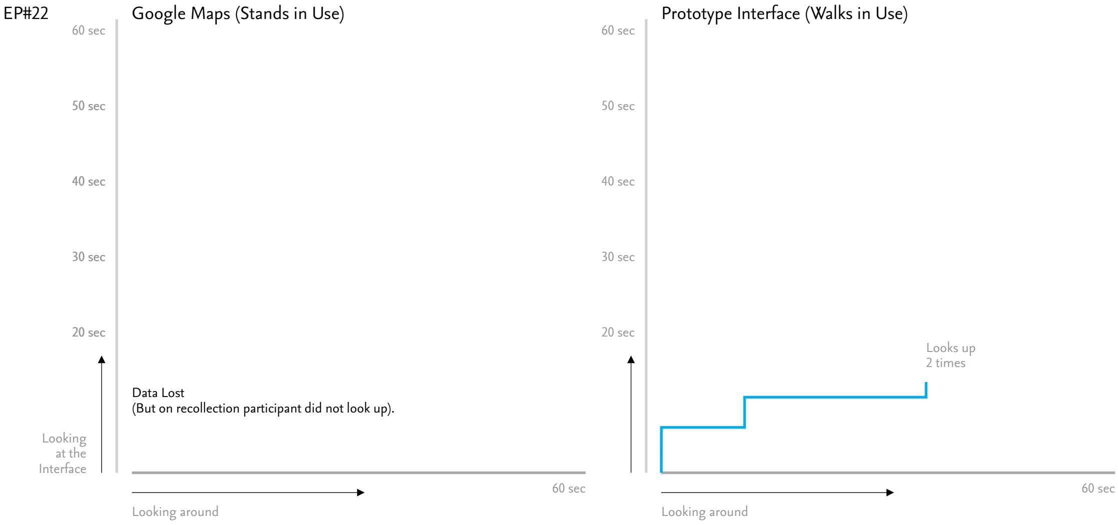


Fig. E.6 EP#22's results.

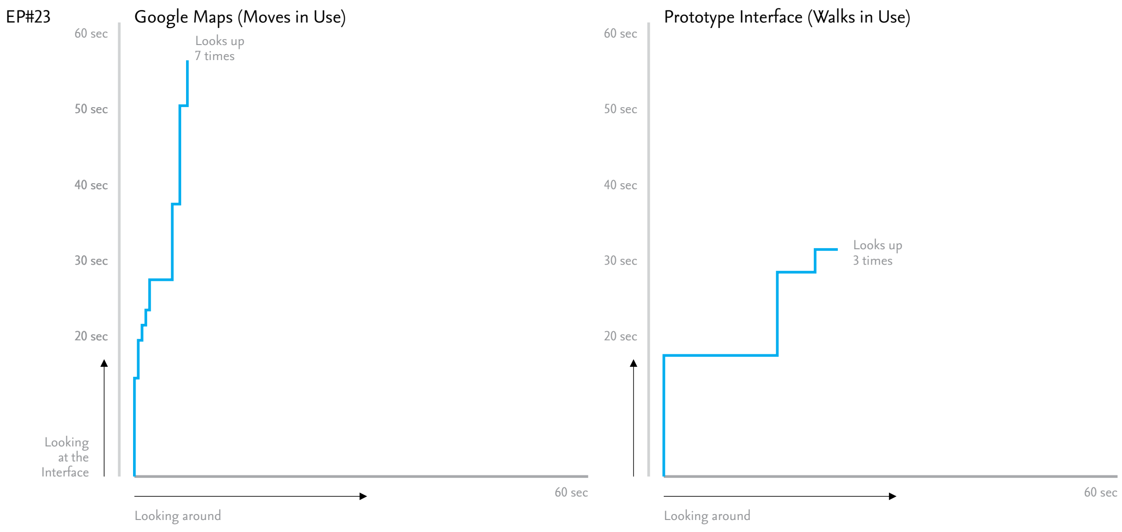


Fig. E.7 EP#23's results.

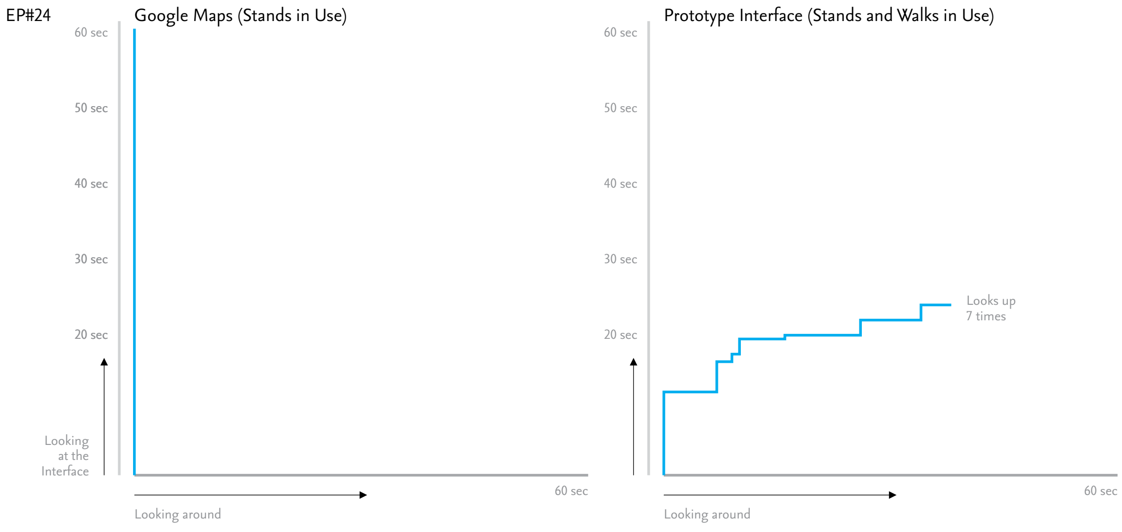


Fig. E.8 EP#24's results.

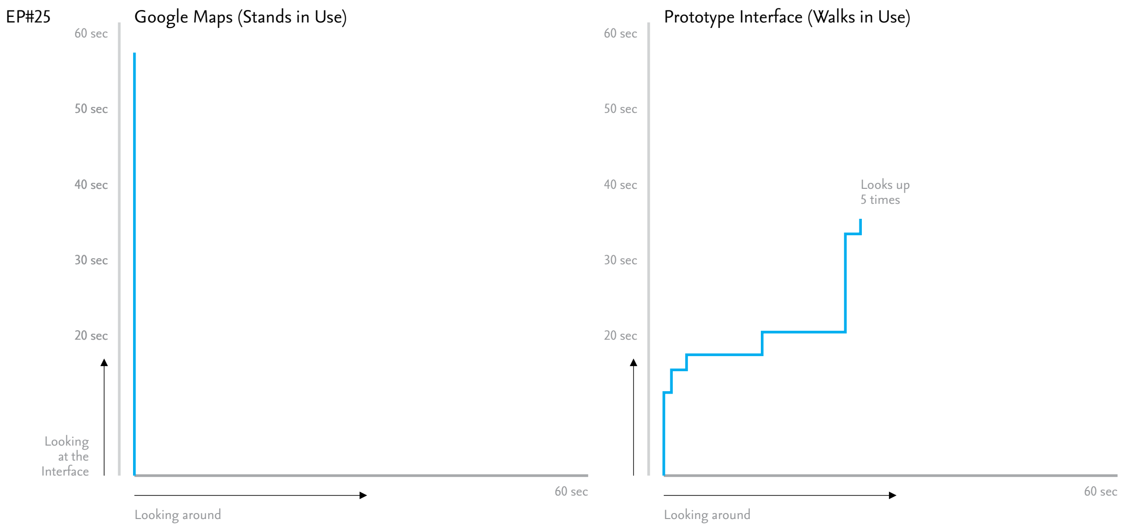


Fig. E.9 EP#25's results.

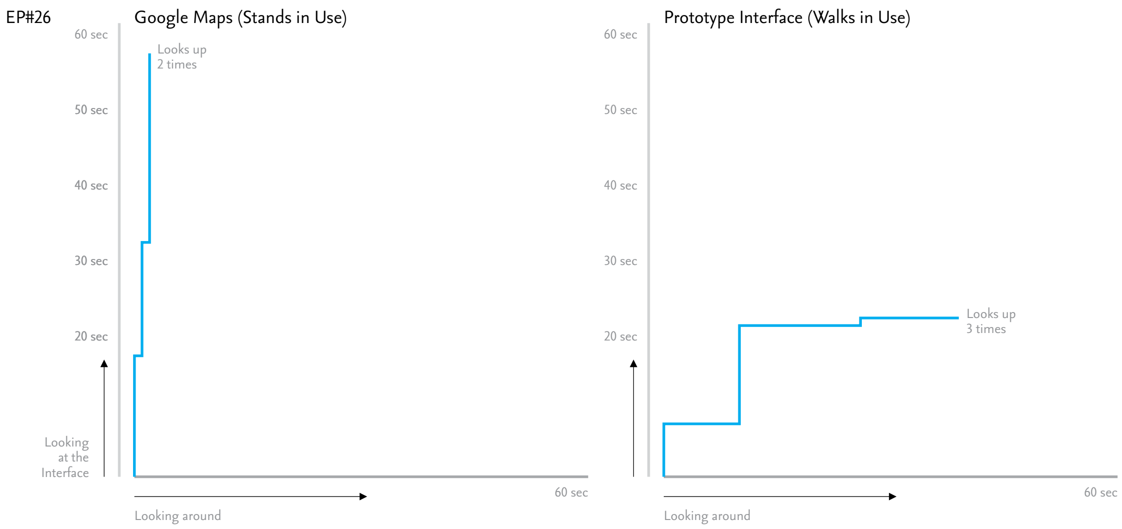


Fig. E.10 EP#26's results.

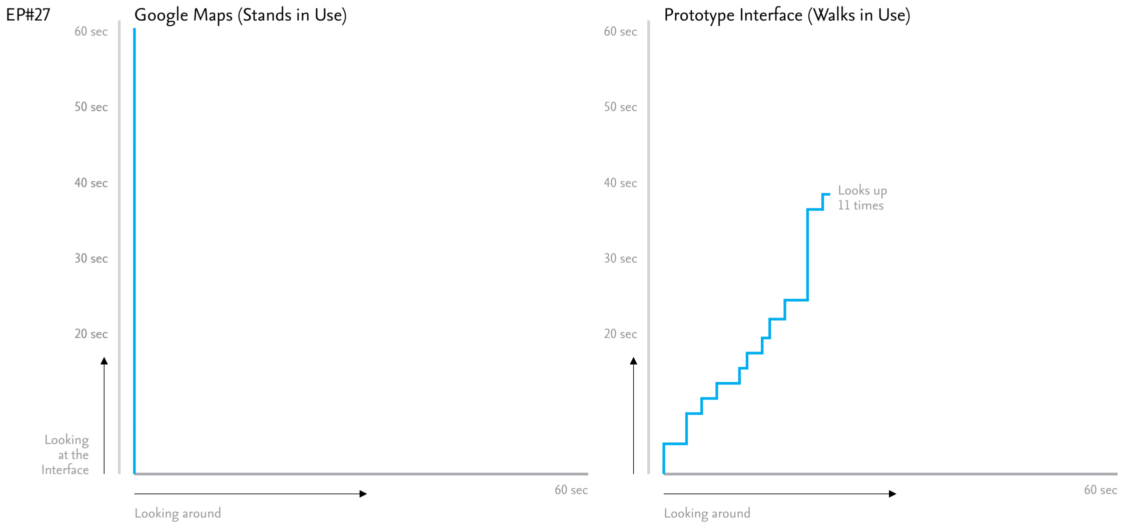


Fig. E.11 EP#27's results.

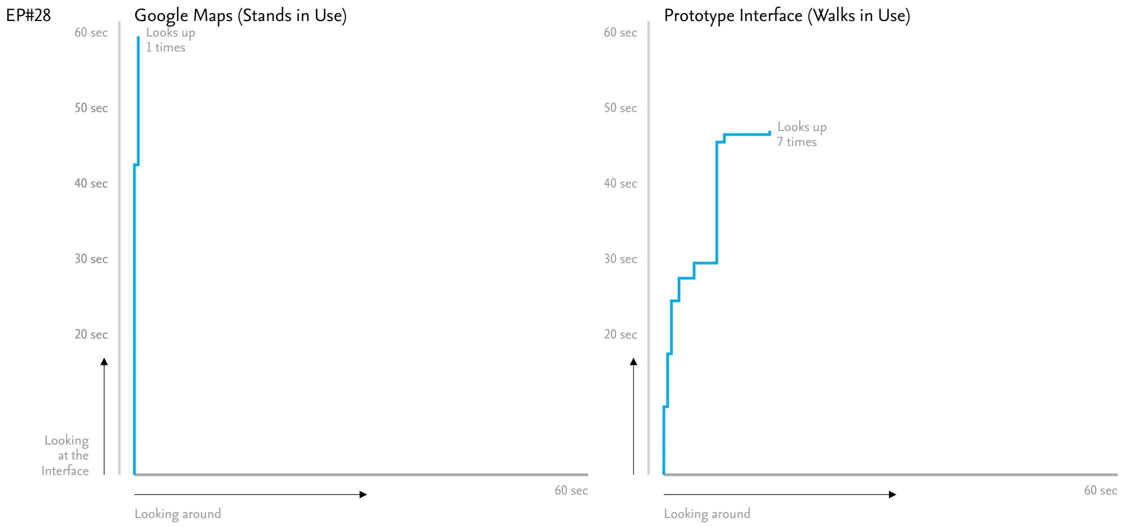


Fig. E.12 EP#28's results.

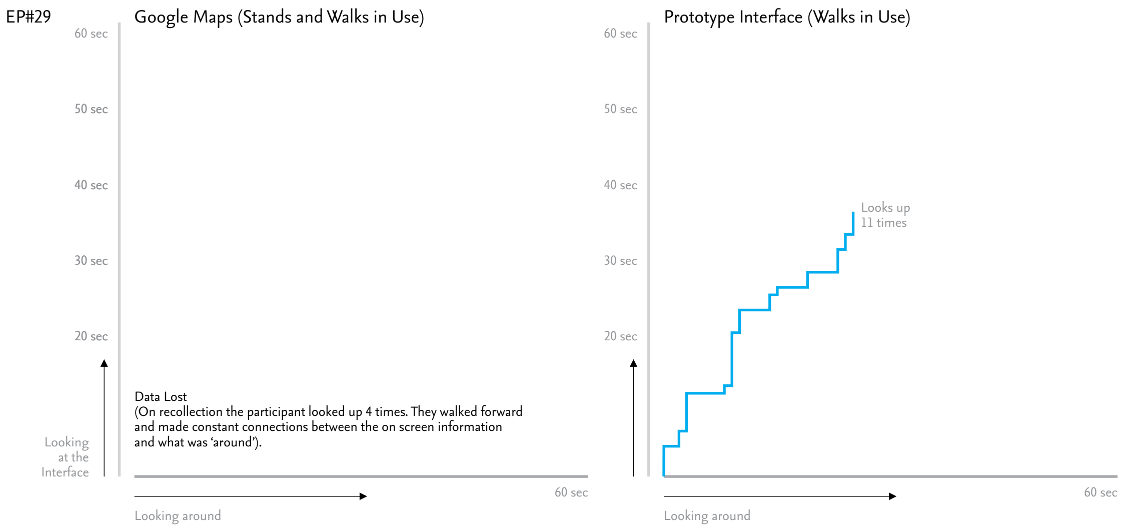


Fig. E.13 EP#29's results.

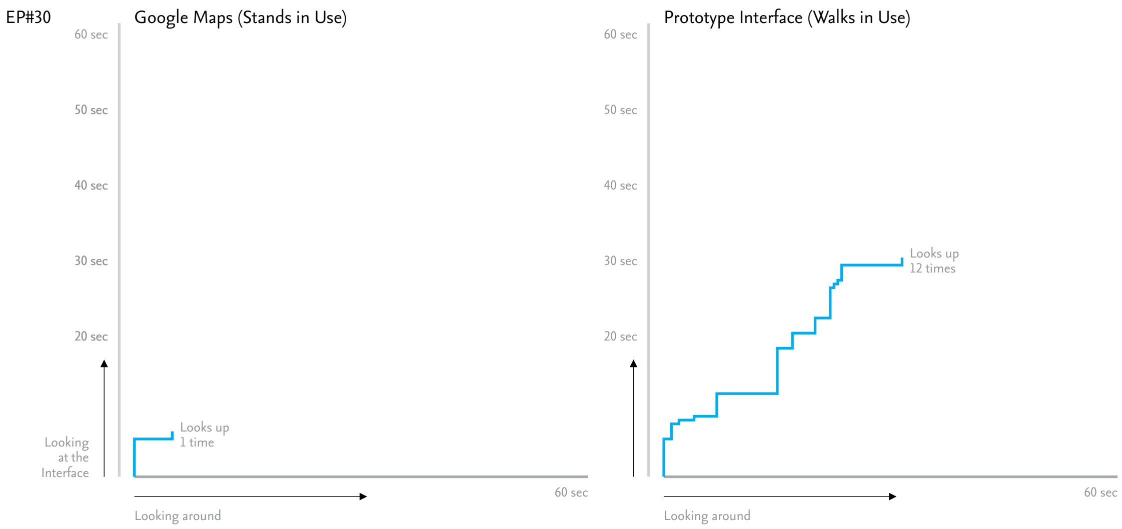


Fig. E.14 EP#30's results.

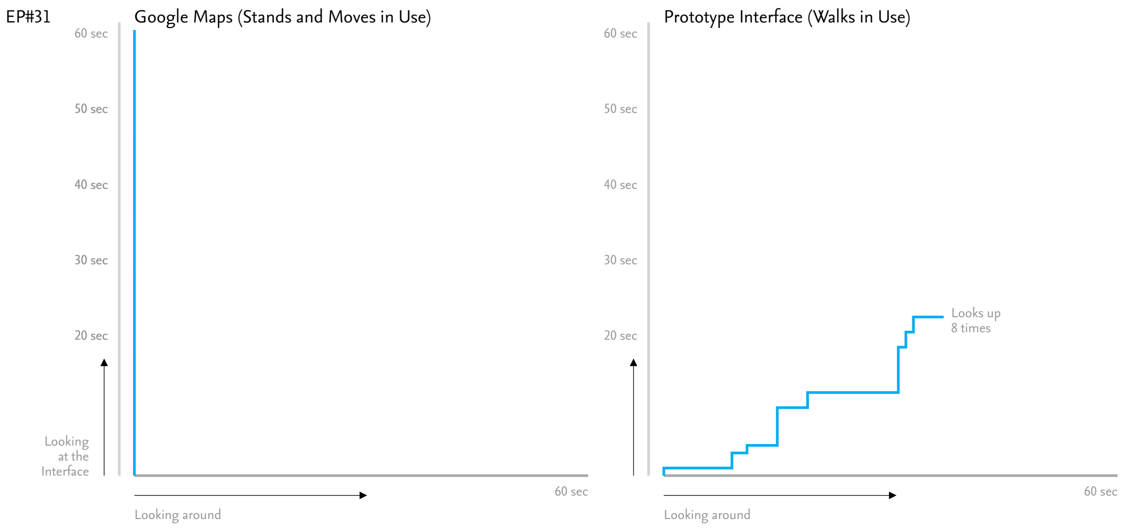


Fig. E.15 EP#31's results.

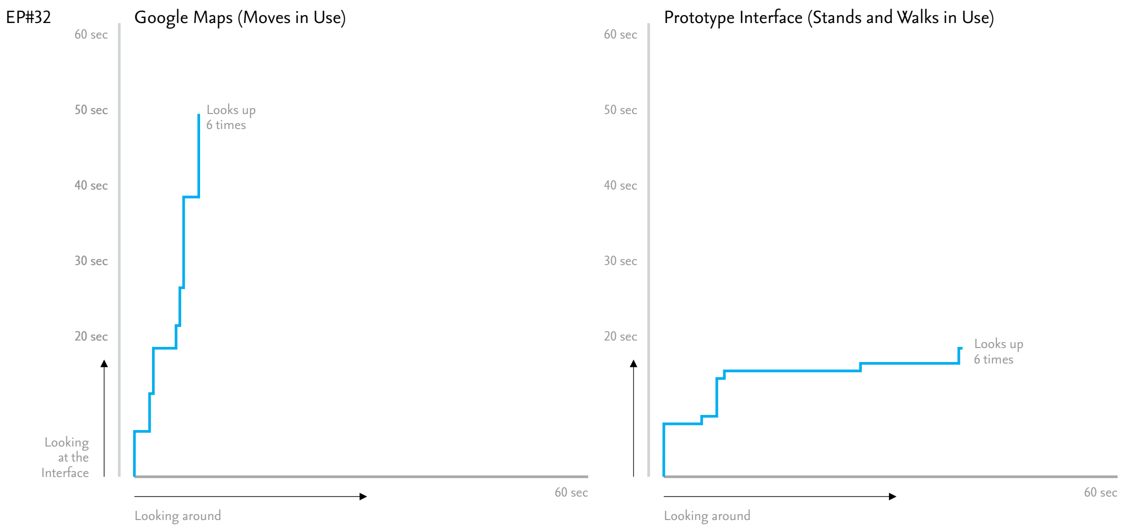


Fig. E.16 EP#32's results.

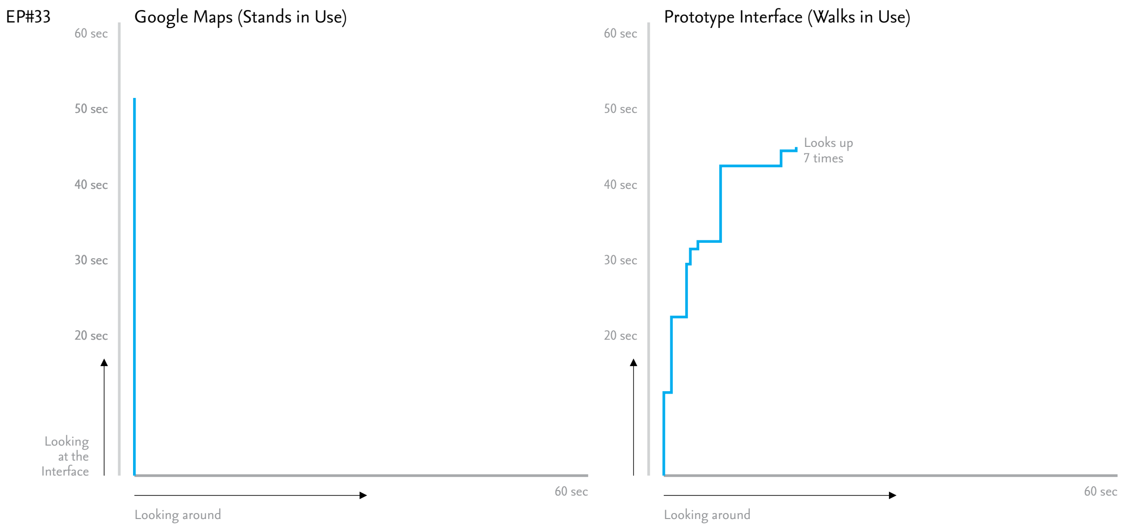


Fig. E.17 EP#33's results.

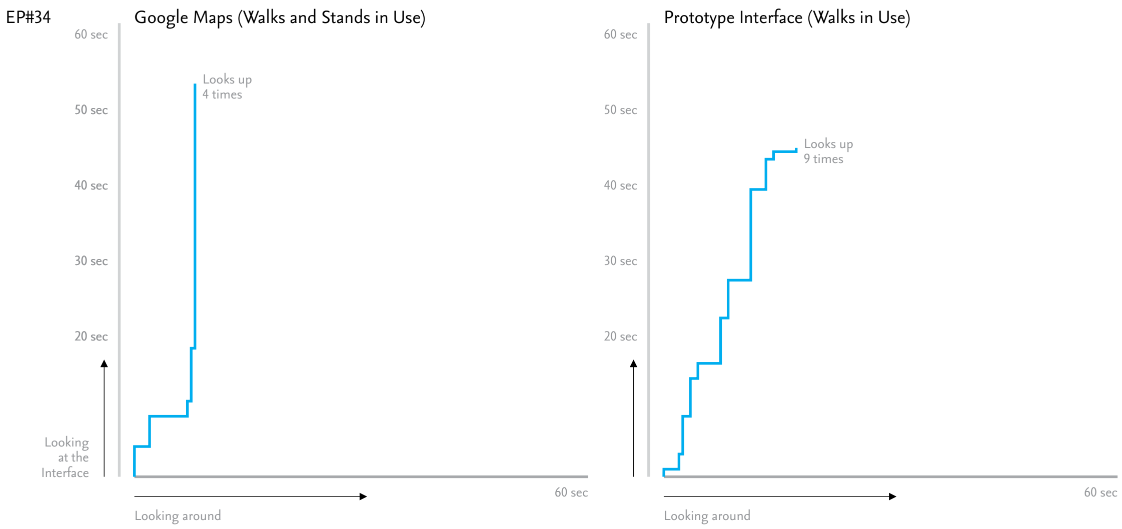


Fig. E.18 EP#34's results.

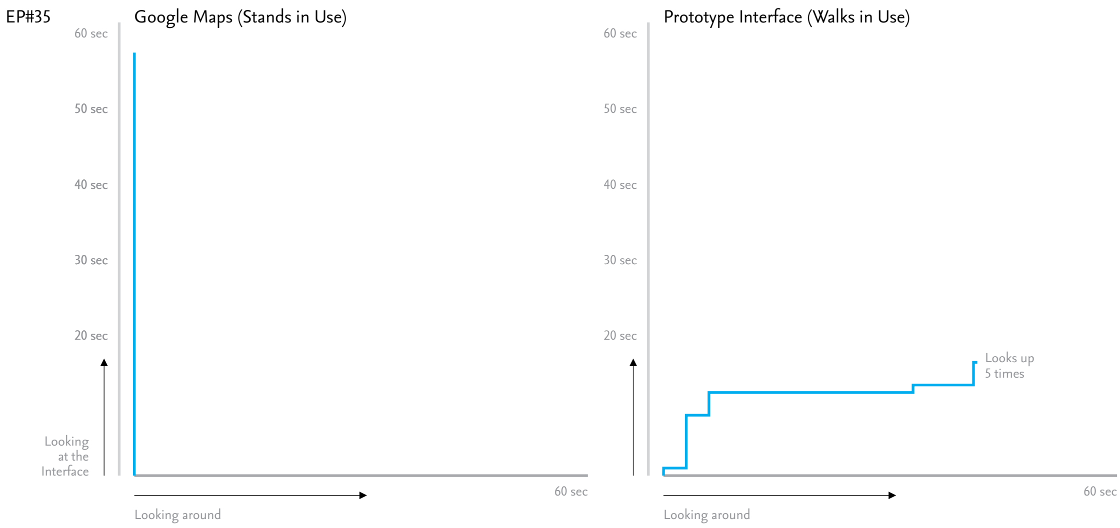


Fig. E.19 EP#35's results.

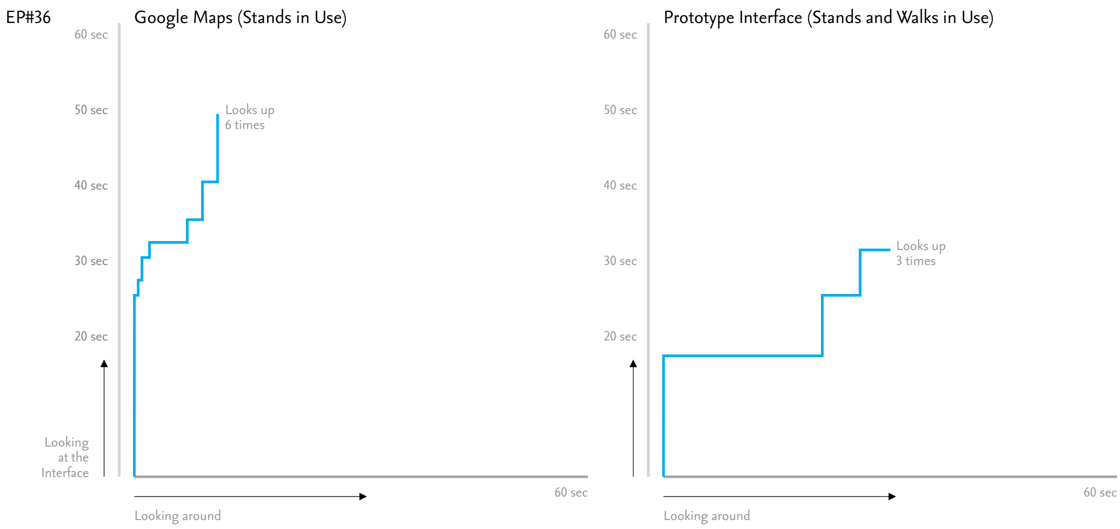


Fig. E.20 EP#36's results.

E.2 Participants' Use of Google Maps and the Prototype Compared in Adapted Diagrams

As may be noted below, in order to enable the qualitization of the data (see Sections 3.3.8.3 and 5.4.5.1), each of the above diagrams have been adapted.

Enabling the qualitization of the frequency of participants' upward glances/gazes, their sample of their use of Google Maps and the prototype is now divided into three even sections. In examining the sample, if a participant was seen to glance upwards in *only one* section it is said that they looked up 'infrequently'. Alternatively, if the participant was seen to look up in *two* sections then it is said that they looked up 'frequently'. Lastly, if the participant was seen to look up in *every* section, then it is said that they looked up 'throughout'.

Further, in order to enable the qualitization of the duration of these upward glances/gazes, a figure representing the *sum* duration is now attached to each diagram. Here, if the overall *sum* duration of the upward glances/gazes (i.e. the total amount of time spent looking up) exceeds the *number* of upward glances/gazes by *one and a half times*, then the participant is said to have looked up *extensively*. If, on the other hand, the overall sum duration does not exceed the number of upward glances/gazes by *one and a half times*, participants are said to have looked up *inextensively*. For an overview of the process, its justification and the results obtained please turn to Section 5.4.5.1.

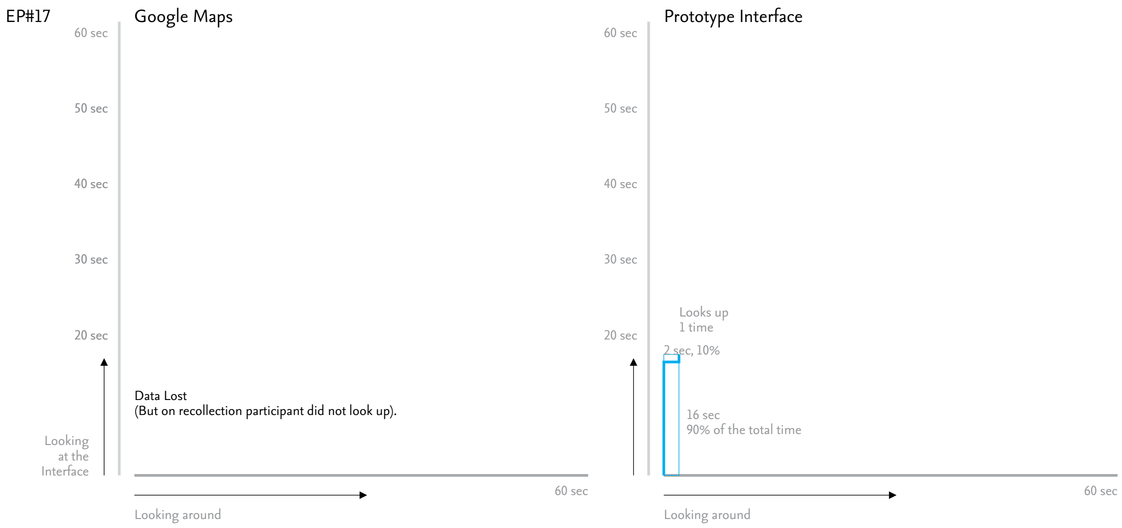


Fig. E.21 EP#17's results with sections and seconds.

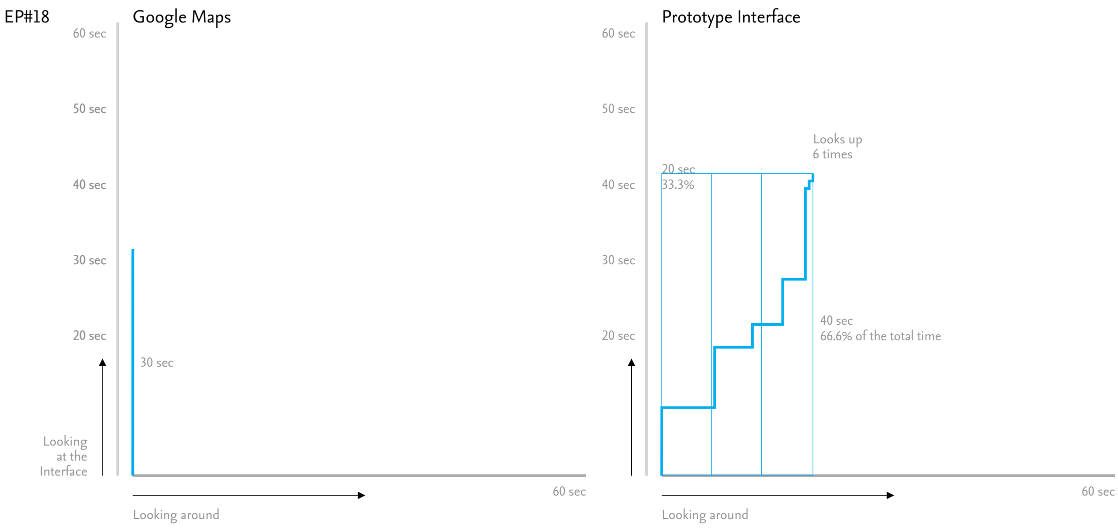


Fig. E.22 EP#18's results with sections and seconds.

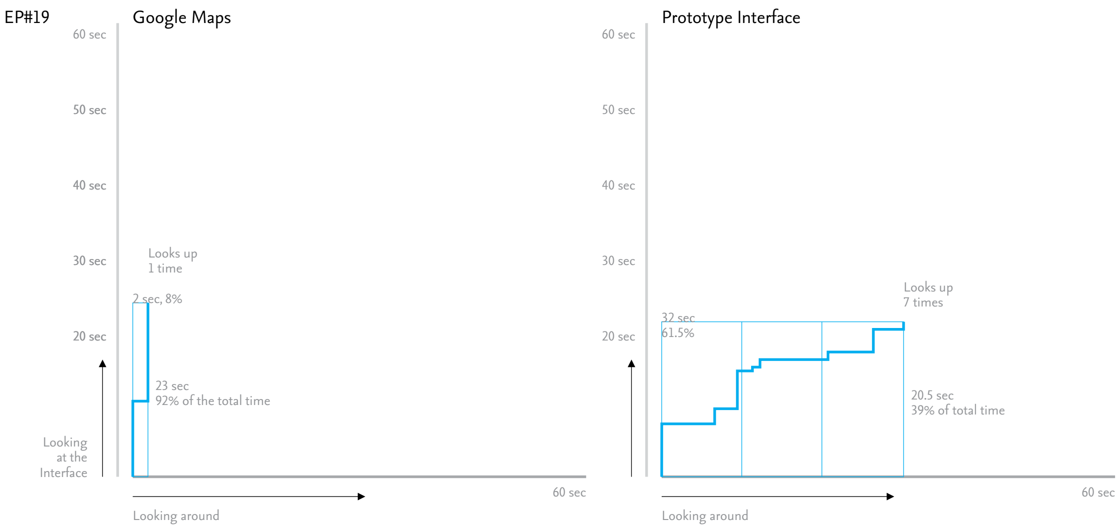


Fig. E.23 EP#19's results with sections and seconds.

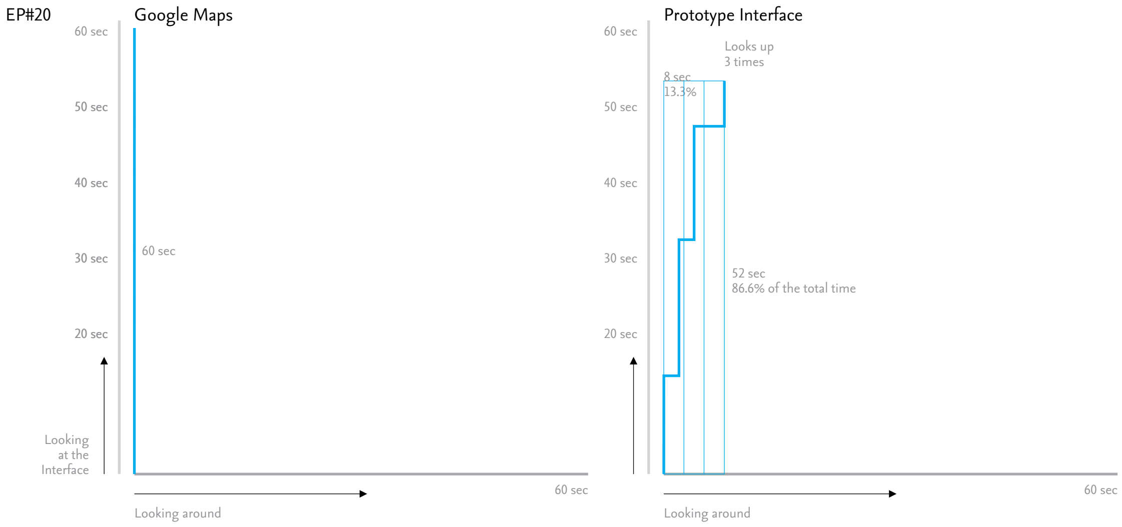


Fig. E.24 EP#20's results with sections and seconds

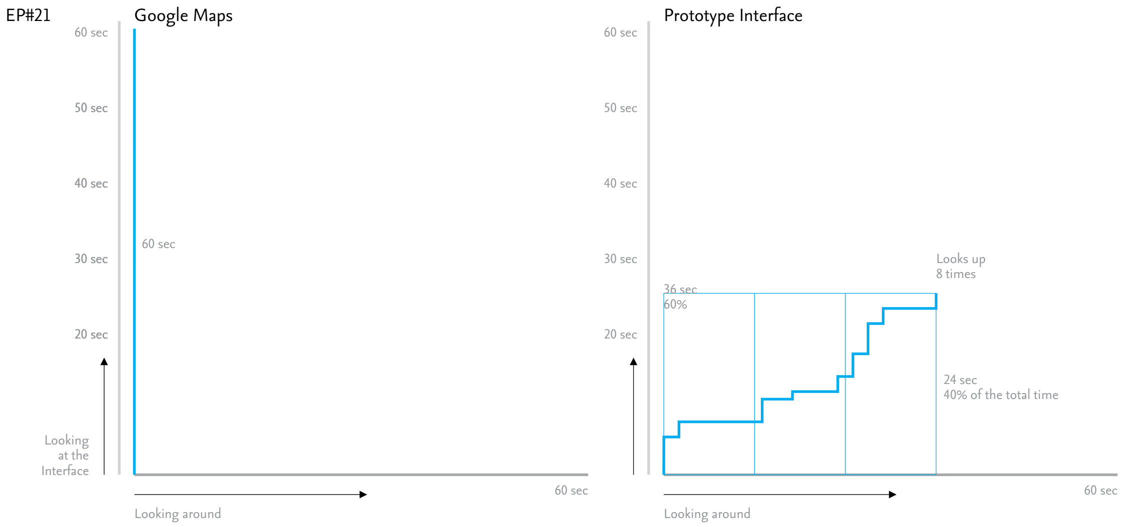


Fig. E.25 EP#21's results with sections and seconds.

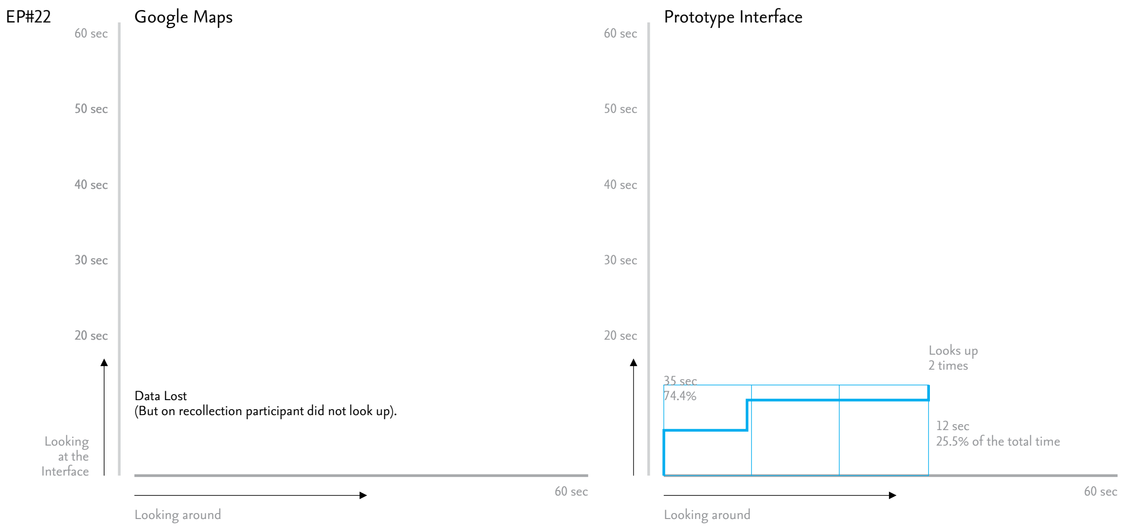


Fig. E.26 EP#22's results with sections and seconds.

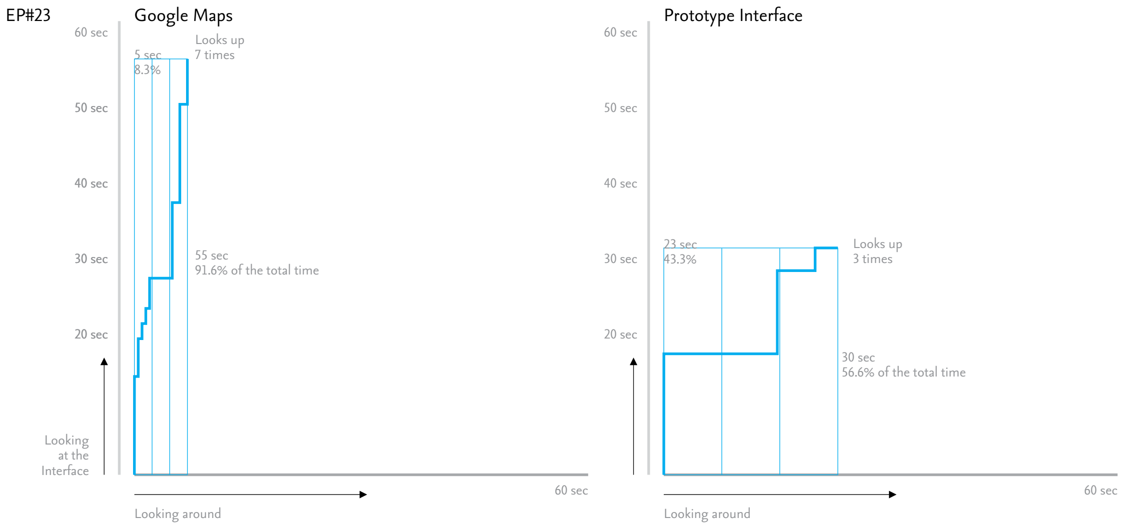


Fig. E.27 EP#23's results with sections and seconds.

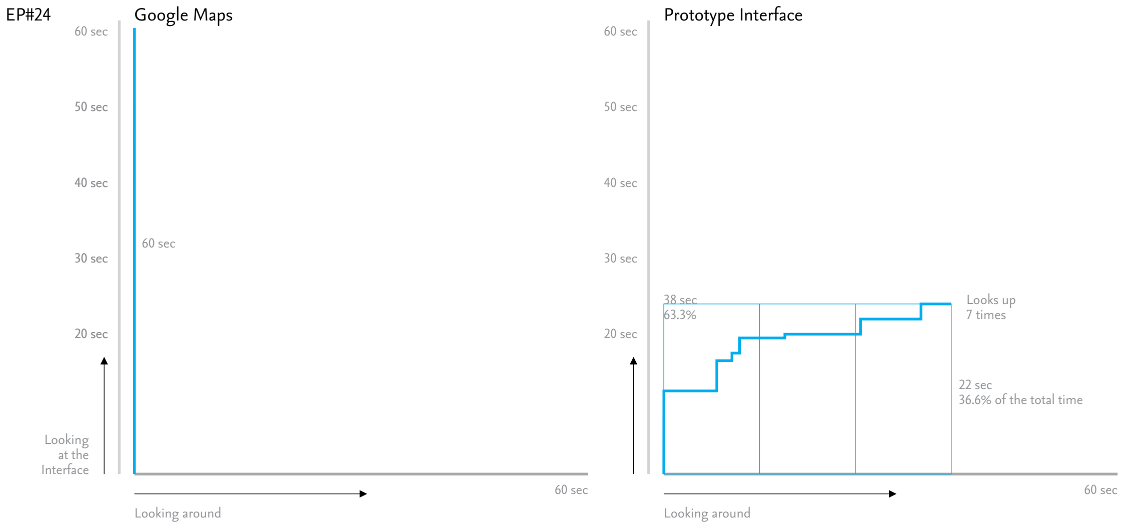


Fig. E.28 EP#24's results with sections and seconds.

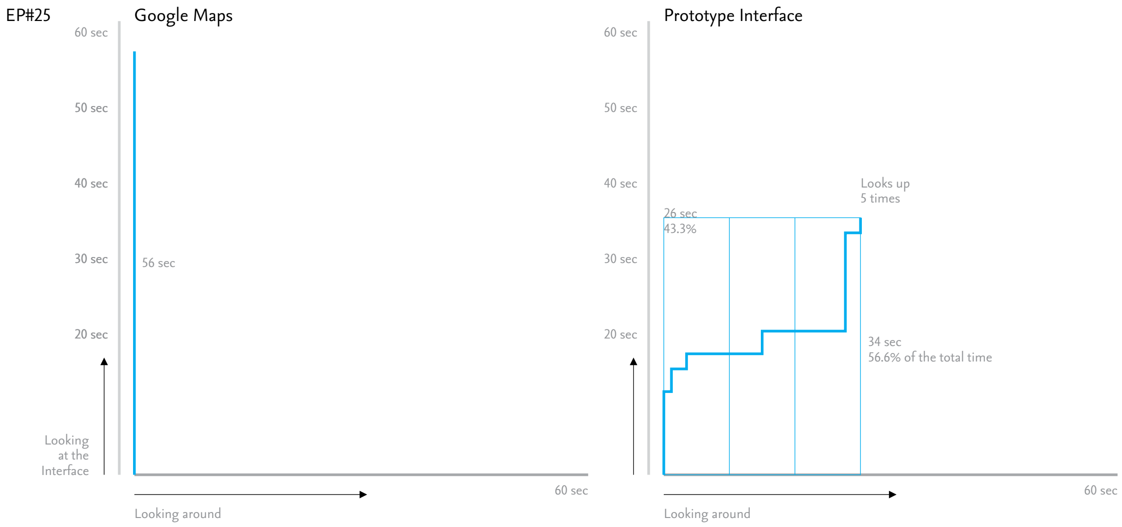


Fig. E.29 EP#25's results with sections and seconds.

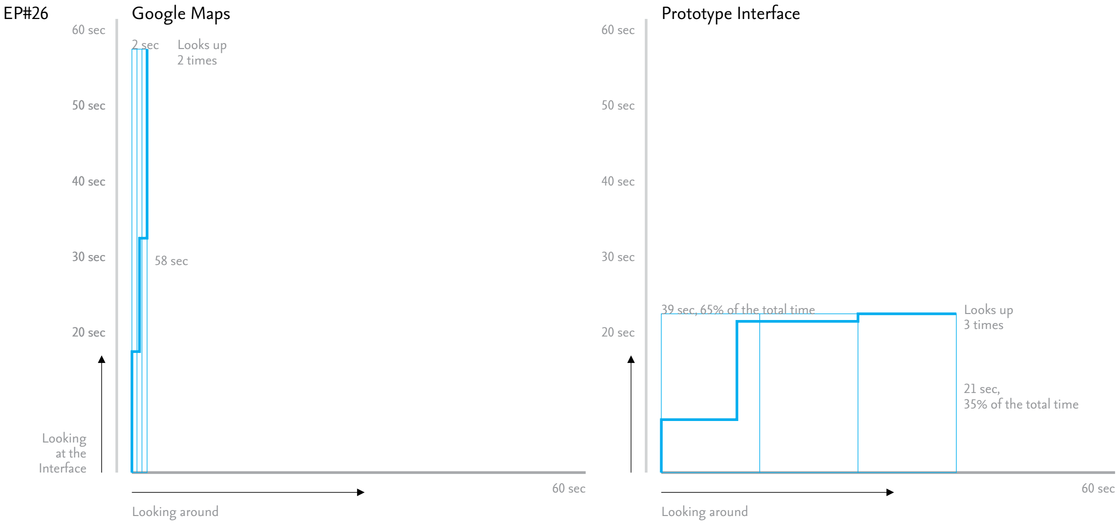


Fig. E.30 EP#26's results with sections and seconds.

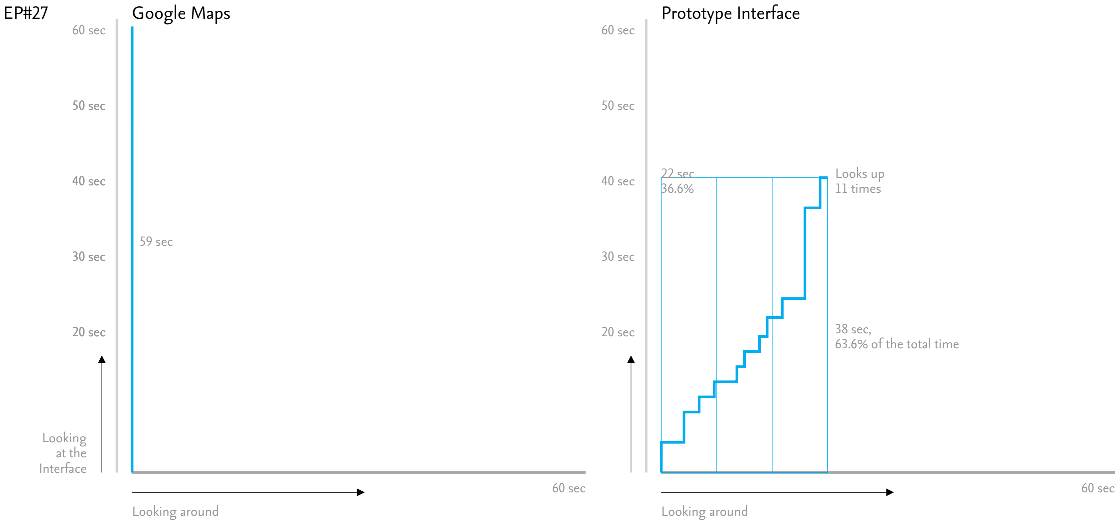


Fig. E.31 EP#27's results with sections and seconds.

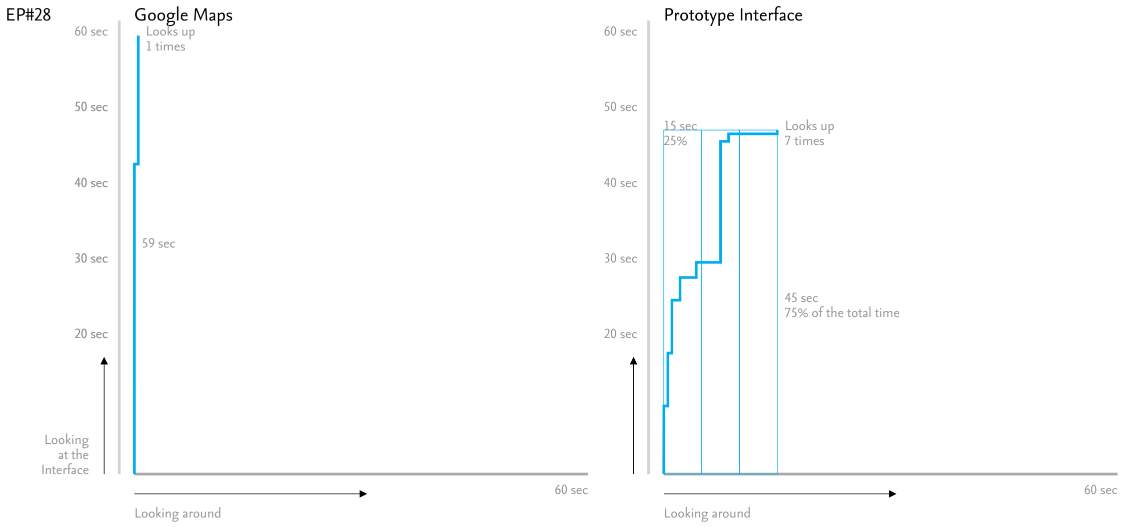


Fig. E.32 EP#28's results with sections and seconds.

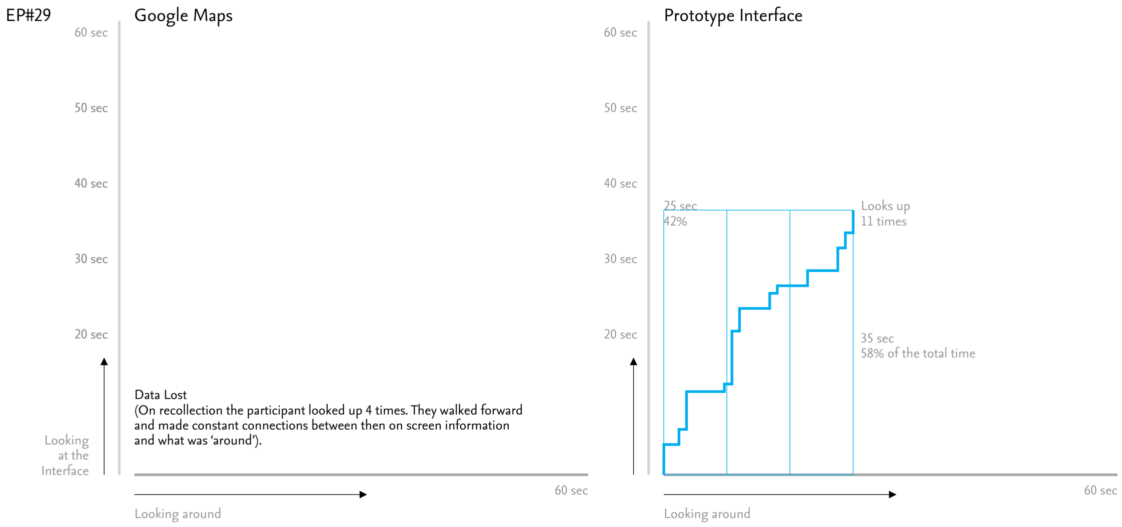


Fig. E.33 EP#29's results with sections and seconds.

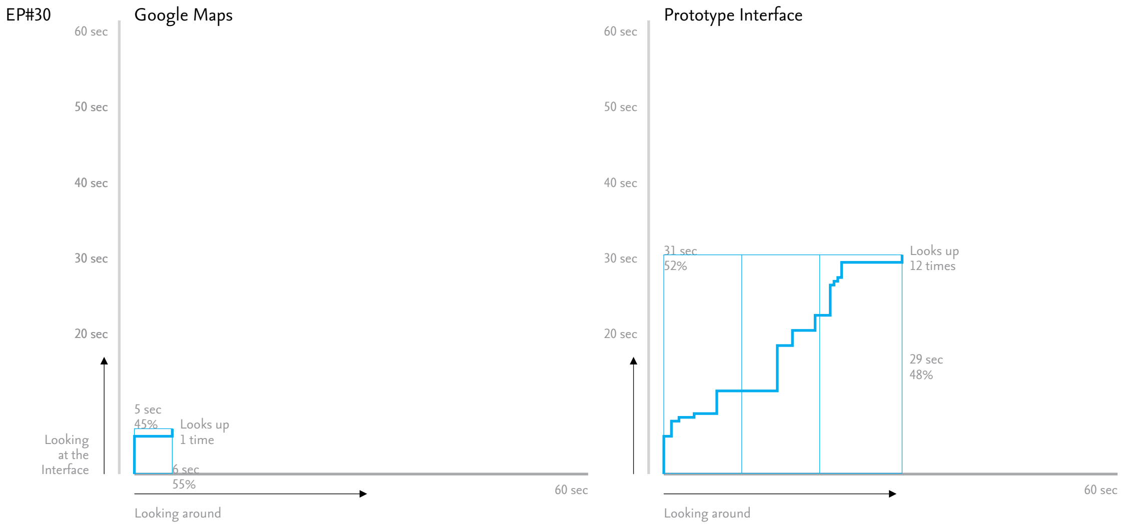


Fig. E.34 EP#30's results with sections and seconds.

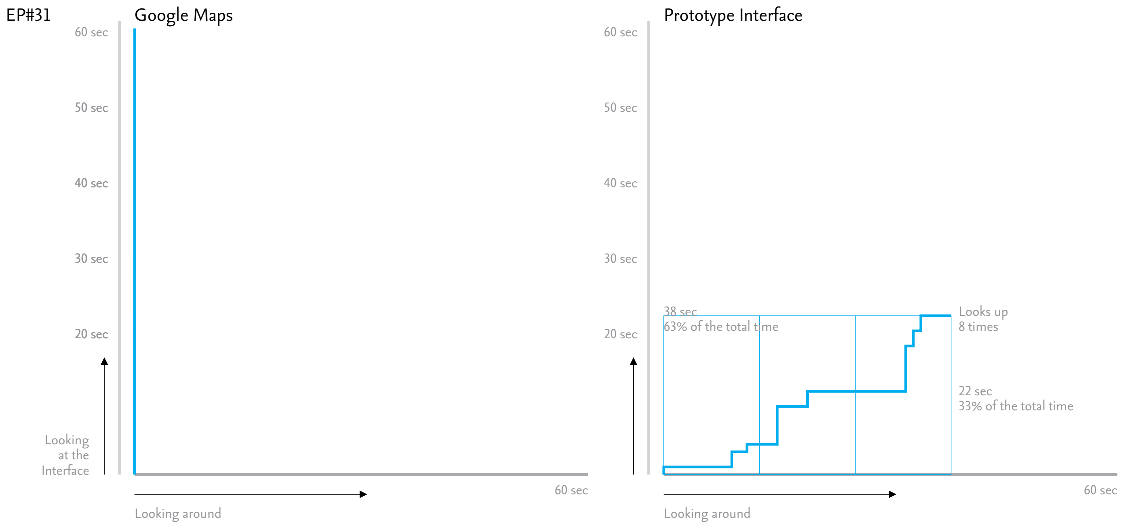


Fig. E.35 EP#31's results with sections and seconds.

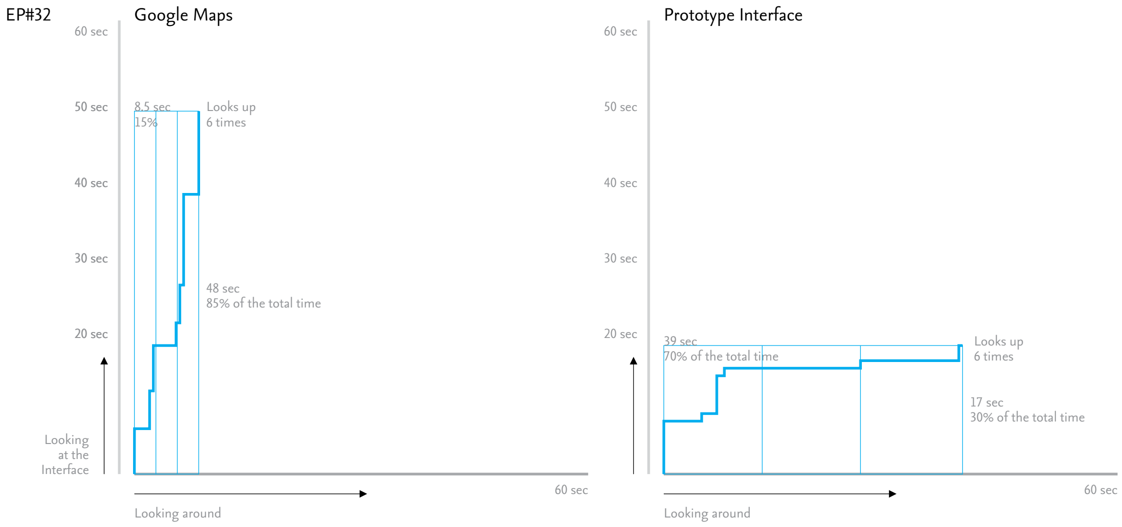


Fig. E.36 EP#32's results with sections and seconds.

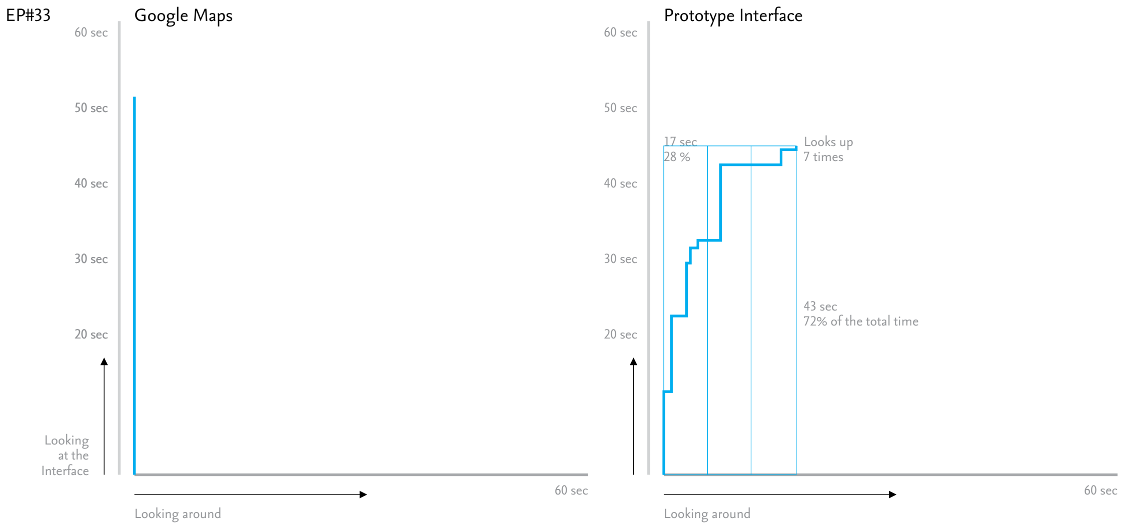


Fig. E.37 EP#33's results with sections and seconds.

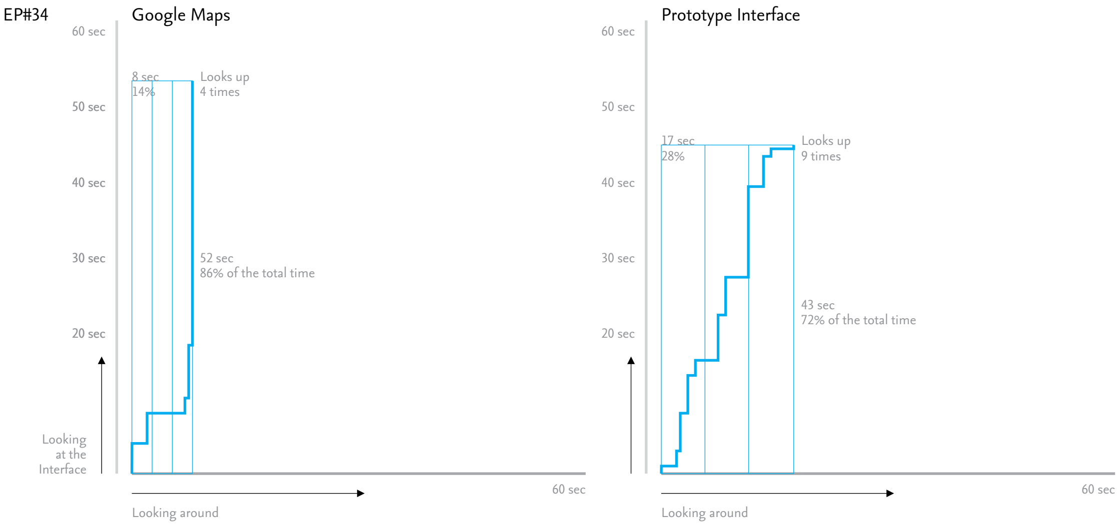


Fig. E.38 EP#34's results with sections and seconds.

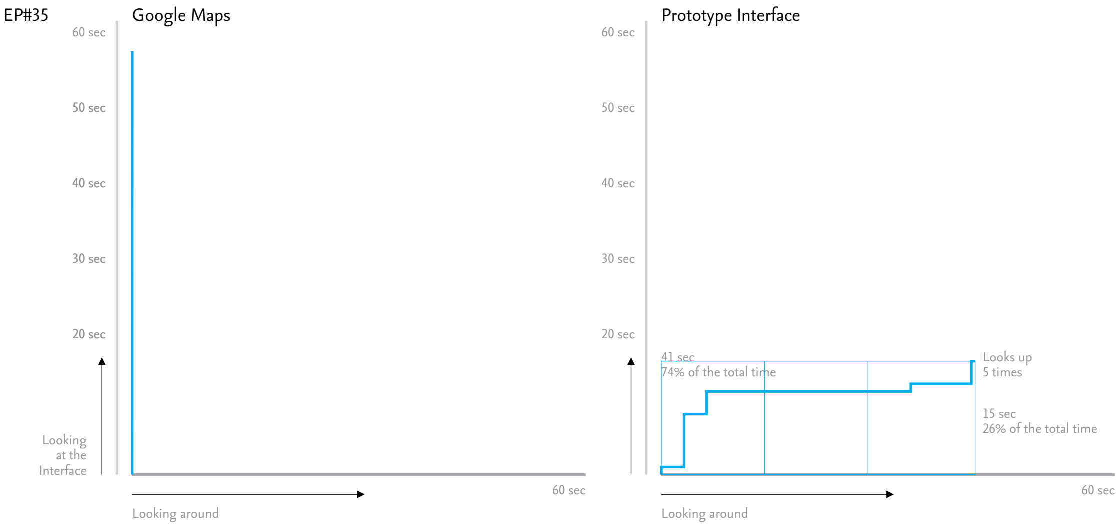


Fig. E.39 EP#35's results with sections and seconds.

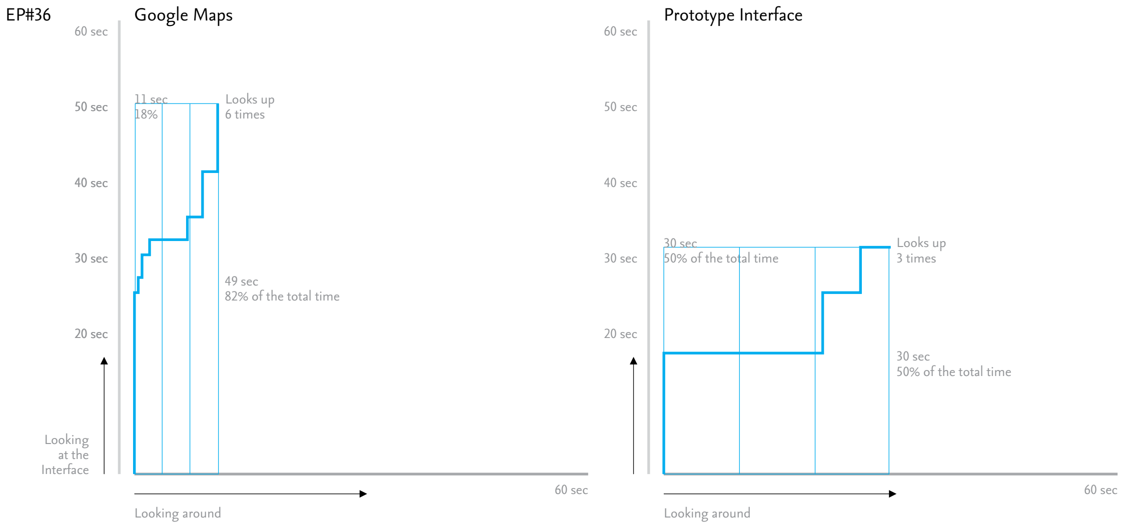


Fig. E.40 EP#36's results with sections and seconds.

E.3 The Results of the Qualitization of Participants' Interface-Environment Interactions

The below tables set out the results of the qualitization of the frequency and duration of participants' upward glances/gazes for both Google Maps and the prototype. (For a textual summary of these results please turn to Section 5.4.5.1).

The Qualitization of the Frequency of Participants' Upward Glances/Gazes in their Use of Google Maps

EP No.	Does the Participant Look up in the 1st Section?	Does the Participant Look Up in the 2nd Section?	Does the Participant Look Up in the 3rd Section?	The Resultant Categorisation
EP#16	Not included	Not included	Not included	Not included
EP#17	No.	No.	No.	Did not look up
EP#18	No.	No.	No.	Did not look up
EP#19	Yes.	No.	No.	Infrequently
EP#20	No.	No.	No.	Did not look up
EP#21	No.	No.	No.	Did not look up
EP#22	No.	No.	No.	Did not look up
EP#23	Yes.	Yes.	Yes.	Throughout
EP#24	No.	No.	No.	Did not look up
EP#25	No.	No.	No.	Did not look up
EP#26	Yes.	Yes.	No.	Frequently
EP#27	No.	No.	No.	Did not look up
EP#28	No.	No.	Yes.	Infrequently
EP#29	Data Lost.	Data Lost.	Data Lost.	Data Lost.
EP#30	No.	Yes.	No.	Infrequently
EP#31	No.	No.	No.	Did not look up
EP#32	Yes.	Yes.	Yes.	Throughout
EP#33	No.	No.	No.	Did not look up
EP#34	Yes.	No.	Yes.	Frequently
EP#35	No.	No.	No.	Did not look up
EP#36	Yes.	Yes.	Yes.	Throughout

Table E.1 A qualitization of the frequency of participants' upward glances/gazes with Google Maps. Here the researcher checked whether the participant looked up in the beginning, the middle and the end of their sample of use.

The Qualitization of the Frequency of Participants' Upward Glances/Gazes in their Use of the Prototype

EP No.	Does the Participant Look up in the 1st Section?	Does the Participant Look Up in the 2nd Section?	Does the Participant Look Up in the 3rd Section?	The Resultant Categorisation
EP#16	Not included	Not included	Not included	Not included
EP#17	No	No	Yes.	Infrequently
EP#18	Yes.	Yes.	Yes.	Throughout
EP#19	Yes.	Yes.	Yes.	Throughout
EP#20	Yes.	Yes.	Yes.	Throughout
EP#21	Yes.	Yes.	Yes.	Throughout
EP#22	Yes.	No.	No.	Infrequently
EP#23	Yes.	No.	Yes.	Frequently
EP#24	Yes.	Yes.	Yes.	Throughout
EP#25	Yes.	Yes.	Yes.	Throughout
EP#26	Yes.	No.	Yes.	Frequently
EP#27	Yes.	Yes.	Yes.	Throughout
EP#28	Yes.	Yes.	Yes.	Throughout
EP#29	Yes.	Yes.	Yes.	Throughout
EP#30	Yes.	Yes.	Yes.	Throughout
EP#31	Yes.	Yes.	Yes.	Throughout
EP#32	Yes.	No.	Yes.	Frequently
EP#33	Yes.	Yes.	Yes.	Throughout
EP#34	Yes.	Yes.	Yes.	Throughout
EP#35	Yes.	No.	Yes.	Frequently
EP#36	Yes.	Yes.	Yes.	Throughout

Table E.2 A qualitization of the frequency of participants' upward glances/gazes with the prototype. Here the researcher checked whether the participant looked up in the beginning, the middle and the end of their sample of use.

The Qualitization of the Duration of Participants' Upward Glances/Gazes in their Use of Google Maps

EP No.	The Number of Times the Participant Looked Up with Google (i.e. the Frequency)	The Sum Duration of the Participant's Upward Glances/Gazes with Google	If the Frequency is Divided by the Sum Duration does the Result Exceed the Former Figure by 1 and ½ Times?	The Resultant Categorisation
EP#16	Not included	Not included	Not included	Not included
EP#17	0	0 sec	N/A	Did not look up
EP#18	0	0 sec	N/A	Did not look up
EP#19	1	2 sec	Yes	Extensively
EP#20	0	0 sec	N/A	Did not look up
EP#21	0	0 sec	N/A	Did not look up
EP#22	0	0 sec	N/A	Did not look up
EP#23	7	5 sec	No	Inextensively
EP#24	0	0 sec	N/A	Did not look up
EP#25	0	0 sec	N/A	Did not look up
EP#26	2	2 sec	No	Inextensively
EP#27	0	0 sec	N/A	Did not look up
EP#28	1	0.5 sec	No	Inextensively
EP#29	4	Recording Failed	Yes (Estimated)	Extensively
EP#30	1	5 sec	Yes	Extensively
EP#31	0	0 sec	N/A	Did not look up
EP#32	6	8.5 sec	No	Inextensively
EP#33	0	0 sec	No	Did not look up
EP#34	4	8 sec	Yes	Extensively
EP#35	0	0 sec	N/A	Did not look up
EP#36	6	11sec	Yes	Extensively

Table E.3 A qualitization of the duration of participants' upward glances/gazes with Google Maps. Here the researcher checked if the total number of upward glances/gazes exceeded the sum duration of these upward glances by 1 and 1/2 times or more.

The Qualitization of the Duration of Participants' Upward Glances/Gazes in their Use of the Prototype

EP No.	The Number of Times the Participant Looked Up with the Prototype (i.e. the Frequency)	The Sum Duration of the Participant's Upward Glances/Gazes with the Prototype	If the Frequency is Divided by the Sum Duration does the Result Exceed the Former Figure by 1 and ½ Times?	The Resultant Categorisation
EP#16	Not included	Not included	Not included	Not included
EP#17	1	2 sec	Yes	Extensively
EP#18	6	20 sec	Yes	Extensively
EP#19	7	32 sec	Yes	Extensively
EP#20	3	8 sec	Yes	Extensively
EP#21	8	36 sec	Yes	Extensively
EP#22	2	35 sec	Yes	Extensively
EP#23	3	32 sec	Yes	Extensively
EP#24	7	38 sec	Yes	Extensively
EP#25	5	36 sec	Yes	Extensively
EP#26	3	39 sec	Yes	Extensively
EP#27	11	22 sec	Yes	Extensively
EP#28	7	15 sec	Yes	Extensively
EP#29	11	22 sec	Yes	Extensively
EP#30	12	31 sec	Yes	Extensively
EP#31	8	38 sec	Yes	Extensively
EP#32	6	39 sec	Yes	Extensively
EP#33	7	17 sec	Yes	Extensively
EP#34	9	17 sec	Yes	Extensively
EP#35	5	41 sec	Yes	Extensively
EP#36	3	30 sec	Yes	Extensively

Table E.4 A qualitization of the duration of participants' upward glances/gazes with the prototype. Here the researcher checked if the total number of upward glances/gazes exceeded the sum duration of these upward glances by 1 and 1/2 times or more.

Appendix F
A Comparison between the Principles of this Enquiry's Contextualised Graphic Syntax and the Principles Presented within Conventional Situation Awareness Literature

At the end of Chapter 2 a conventional definition of situation awareness (SA), drawn from performance-related psychology literature, was presented. Here, SA was defined as: 'the perception of the elements in the environment within a volume of space and time, the comprehension of their meaning, and the projection of their status into the near future' (Endsley 1988, here quoted from Endsley and Jones 2012:13).

It was acknowledged that work undertaken in accordance with this definition is of immense value in its domain of application (i.e. complex dynamic environments such as air-traffic control). However, it was also stated that this enquiry frames and defines the concept somewhat differently.

As was outlined in Section 2.3.1, within this enquiry, the walker's/wanderer's experience of the environment is seen as being grounded in their embodied involvement in that environment, i.e. their *situation*. Hence, it follows that walkers must perceive and comprehend their environment *through* embodied involvement within that environment.

In taking this view, it was stated that SA, therefore, would here refer to

a person's awareness of their embodied involvement in the surrounding environment.

The above definition does not make reference to either 'perception' or 'comprehension'. Both are seen as entwined in experience, and the concept of 'awareness', in turn, is seen to irreducibly enfold the two. Further to this, it will also be noted that the above definition is solely concerned with a person's awareness in the *present*, and not with their ability to project 'into the future'. As projection into the future appears to be essential to psychological understandings of SA, its absence in this enquiry's framing may be taken as the key distinguishing factor between the two.

Later in the enquiry, a contextualised graphic syntax *for* design (Engelhardt 2002; Zimmerman et al. 2010; see Section 3.1.2) was presented arising from the above definition (see Section 6.4). In setting out a series of principles, this graphic syntax provides an outline for the design of a GPS-enabled WI to visually support a walker's/wanderer's situation awareness in use.

With this to hand, it is here noted that we may also find guidance relating to the design of interfaces to support SA in literature aligned to the conventional definition of SA. Endsley and Jones (2012), in particular, are seen to give this area extensive consideration. The pair offer a list of principles pertaining to the design of interfaces for complex, dynamic environments such as air-traffic control and inflight navigation systems. These principles draw not only from their own research findings, but also more broadly from the field of psychology. While it is clear that a somewhat different understanding of SA underpins this work, the view is taken that a look at the principles would provide a worthwhile insight into what—if anything—may be considered divergent in relation to the principles contained in this enquiry's contextualised graphic syntax.

In total, Endsley and Jones set out eight principles (pp.79-84), which are mostly concerned with the design of interfaces such that their users may be supported in maintaining an *overview* of a complex dynamic environment *through* the interface. As per the former psychological definition, focus is throughout directed towards ensuring that the user's perception, comprehension and projection in relation to 'elements in the environment' is optimized.

With their first principle, Endsley and Jones recommend that, as has happened here, the design of the interface be framed around a specific task (p.79). As we have seen in this enquiry, the design of the interface was framed around *orientating* the walker/wanderer (see Section 4.3).

With their second principle Endsley and Jones state that the interface should 'provide information that is processed and integrated' so that the user need not perform calculations in order to comprehend what they see (ibid). Here, it is suggested that pertinent variables be 'graphically depicted' so that they can be 'readily determined with a quick glance' (p.80). Such a principle is in alignment with those set out in this enquiry, wherein it is recommended that the walker/wanderer be provided with an interface which orientates the walker and relates to the immediate environment, through *a limited amount of content*. From Endsley and Jones's perspective, we may see the final interface as an instance of 'processed and integrated' information being provided in order to support the walker/wanderer gain an understanding of their present orientation within a given environment.

Leading on from the above, the third principle requires that a user's ability to project into the future is supported. As has already been noted above, this enquiry's framing and definition of SA is solely concerned with a person's awareness in the *present*, and not with their ability to project 'into the future'. Thus, no alignment may here be drawn with the principles of this enquiry's contextualised graphic syntax. However, in order that the walker/wanderer may relate to the surrounding environment, this enquiry's contextualised graphic syntax does suggest that moving labelled nodes, involved in a literal correspondence with the direction and order of landmarks and districts be provided. These may be understood as potentially *indirectly* supporting a user's ability to project into the future.

The next principle, number four, states that a 'global' perspective or overview should be offered to the user (p.81). In attempting to draw a comparison with the principles of this enquiry's contextualised graphic syntax, it is possible to interpret this in two ways. On one hand we might say that the interface has sought to provide the user with a global perspective, which indicates the direction of features in the environment. On the other, we might say that a global perspective has been avoided in the sense that, in order to ensure that exploratory wayfinding practices are still possible (see Section 4.3), the interface only provides a limited amount of content. Considering both understandings of 'global' it would seem more likely that the latter is in fact the case (i.e. that a global perspective has been avoided). In taking this view, we may say that as a result of seeking to ensure that exploratory wayfinding practices are still possible, a global perspective has been avoided in the interface design. Here, a clear divergence emerges.

The following principle, number five, leads on from the above. It requires that the design of the interface around a specific task and the provision of a global perspective be seen to compliment one another. As no global perspective has been offered within this design, no effort has been made to ensure that the two approaches compliment each other and, as such, another divergence may be noted.

Continuing down the list, it is noted that the next three principles—principles number six through to eight—are all to a greater or lesser extent concerned with the *interactivity* of the interface. As has been noted in the overview of the enquiry's limitations (see Section 7.7.3), this research has not dealt directly with the interactivity of GPS-enabled wayfinding interfaces. Further, in principle seven, in particular, consideration is given to non-visual modes of perception and so, again, the principle may be seen to extend beyond the remit of this enquiry. Consequently, no direct comparison can be made between these principles and those contained within this enquiry's contextualised graphic syntax.

However, it is worth noting that the last principle, number eight, makes a recommendation in relation to information filtering, i.e. reducing the amount of data presented to the user (p.83). The pair assert that computer-driven information filtering is 'detrimental' to the user's development of a 'global' SA, that is, their understanding of the 'system'. Instead, they recommend that users be given control over the filtering of information. This aligns with the recommendations of the present enquiry, wherein it has been noted that future research might look at providing users with the option to vary the amount of on screen information, or select particular *types* of content to be displayed (see Section 7.8.2).

Thus, reflecting on Endsley and Jones's principles as a set, we may say that to a large extent there is alignment between the general principles provided by Endsley and Jones and the principles of this enquiry's contextualised graphic syntax. Reviewing the full list however, a key divergence has been identified in relation to the provision of a *global perspective* within the interface. In seeking to ensure that the urban recreational walker/

wanderer is still able to apply exploratory wayfinding practices such a recommendation has been avoided within this enquiry.

Gathering the whole, it would appear that we may divide the approaches in simple terms. In the broadest sense, Endsley and Jones, place great emphasis on the support of global situation awareness in order that a *system* can be understood. On this view the interface becomes the access-point through which an otherwise intangible complex, dynamic environment is revealed. As a result they are singularly concerned with the user's interactions with the interface's representations such that accurate projections can be made.

In contrast, the present enquiry is concerned with the user's interactions with the interface *alongside* the environment, i.e. to their interface-environment interactions. As such, the contextualised graphic syntax that has been generated here reduces the role of the interface to a component within a larger process, i.e. exploratory wayfinding (see Section 2.3.2.1). Within this framing, interface-based, global perspectives are not seen as relevant or indeed appropriate.

Appendix G
An Overview of the Interface's Architecture

The interface's architecture was based on a combination of HTML 5, CSS, and JavaScript. Each of the named components supported a separate aspect of the prototype. HTML 5 refers to Hyper Text Mark-up Language. It allowed the on screen content to be set out. CSS refers to Cascading Style Sheets. It allowed this content to be arranged and presented in the desired fashion. JavaScript, literally a script language, supported the prototype's functionality. Thus, when a participant pressed a button, JavaScript queried their position and compared that position to an array of *possible* positions held in a small database. If a match was found JavaScript responded by downloading a unique image/WI linked to that match (see Section 5.4.1 for further details).

Below the functioning HTML, CSS and JavaScript is set out as presented on the webpage used in the test. Please note that the coordinates contained in the locations array within the boundingBox variable are specific to Glasgow's Kelvingrove Park. Any retesting of this mark-up would require that these coordinates be updated so as they reference specific local coordinates. Equally, in the latter section of the mark-up, new images must also be identified in functions A through to I. (A .html file containing the following is available on the Memory Key found on the inside cover of this thesis).

```
<!DOCTYPE html>
<html>
<head>
<script src="http://ajax.googleapis.com/ajax/libs/jquery/1.10.2/jquery.min.js">
</script>

<style>

 html {
    width: 100%;
    height: 100%;
}

 body {
    width: 100%;
    height: 100%;
}


 #compass{
    width:960px;
    max-width: 100% !important;
    position:fixed;
    transform-origin: 50% 50%;
    -webkit-transform-origin: 50% 50%;
    -moz-transform-origin: 50% 50%;
 }

 #name{
    font-family: Arial, Helvetica, sans-serif;
    font-size:3em;
    left: 0;
    position:absolute;
    text-align:center;
    top: 42.5%;
    width: 100%;
}

 #buttonBox {
   width:100%;
   position:fixed;
   bottom: 20px;
   text-align:center;
   height:10%;
}

.button{
   appearance: button;
```

```
   -moz-appearance: button;
   -webkit-appearance: button;
   font-family: Arial, Helvetica, sans-serif;
   font-size:3em;
   width: 210px;
}

</style>
</head>

<body>

<div id=”compassContainer”>

<p id=”spin”></p>
<img id=”compass” src=””></img>

</div>

<div id=”buttonBox”>

       <a class=”button” id=”button2” onclick=”Jump()”>Map Me!</a>
              </div>

<div id=”name”><p></p></div>

<script>

                function Jump ()

                {
window.location.reload();
                 }
var x=document.getElementById(“demo”);
var boundingBox={

places : {

                            place : [

              {location : ‘A’,
              east : -4.00000,
              west : -4.90000,
              north : 55.87200,
              south : 55.87170,
              },
```

{location : 'B',
east : -4.00000,
west : -4.90000,
north : 55.87169,
south : 55.87140,
},

{location : 'C',
east : -4.00000,
west : -4.90000,
north : 55.87139,
south : 55.87070,
},

{location : 'D',
east : -4.00000,
west : -4.90000,
north : 55.87029,
south : 55.86995,
},

{location : 'E',
east : -4.00000,
west : -4.90000,
north : 55.86994,
south : 55.86945,
},

{location : 'F',
east : -4.00000,
west : -4.90000,
north : 55.86944,
south : 55.86880,
},

{location : 'G',
east : -4.00000,
west : -4.90000,
north : 55.86879,
south : 55.86830,
},

{location : 'H',
east : -4.00000,
west : -4.90000,
north : 55.86829,
south : 55.86795,
},

```
        {location : 'I',
        east : -4.00000,
        west : -4.90000,
        north : 55.86794,
        south : 55.86755,
        }
                ]
        }
}

var canvasZones={
        Zones : {

Zone :

[{Pl:'A'},{Pl:'B'},{Pl:'C'},{Pl:'D'},{Pl:'E'},{Pl:'F'},{Pl:'G'},{Pl:'H'},{Pl:'I'}]
}
}

 if (navigator.geolocation)
  {
  navigator.geolocation.getCurrentPosition(compareLocation);
  }
 else{x.innerhtml="Geolocation is not supported by this browser.";}

function compareLocation(position)
 {
         $.each(boundingBox.places.place, function(i, v) {
if (position.coords.longitude < v.east && position.coords.longitude > v.west && position.coords.latitude <
v.north && position.coords.latitude > v.south)
                {
                var here = v.location;
                }
$.each(canvasZones.Zones.Zone, function(i, v) {
if (here === v.Pl)
                {
                window[v.Pl]();
                }
 })
 })
 }

 function A()
 {

         var logo = document.getElementById('compass');
         logo.src="Images/9Map.png";
```

```
        var hope = document.getElementById('name');
        hope.innerhtml = "Gibson" + "</br>" + "Street";
        Twirl();
}

 function B()
{

        var logo = document.getElementById('compass');
        logo.src="Images/8Map.png";
        var hope = document.getElementById('name');
        hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
        Twirl();
}

  function C()
{

        var logo = document.getElementById('compass');
        logo.src="Images/7Map.png";
        var hope = document.getElementById('name');
        hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
        Twirl();
}

  function D()
{

        var logo = document.getElementById('compass');
        logo.src="Images/6Map.png";
        var hope = document.getElementById('name');
        hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
        Twirl();
}

  function E()
{

        var logo = document.getElementById('compass');
        logo.src="Images/5Map.png";
        var hope = document.getElementById('name');
        hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
        Twirl();
}

  function F()
{
```

```
            var logo = document.getElementById('compass');
            logo.src="Images/4Map.png";
            var hope = document.getElementById('name');
            hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
            Twirl();
}

  function G()
{

            var logo = document.getElementById('compass');
            logo.src="Images/3Map.png";
            var hope = document.getElementById('name');
            hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
            Twirl();
}

  function H()
{

            var logo = document.getElementById('compass');
            logo.src="Images/2Map.png";
            var hope = document.getElementById('name');
            hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
            Twirl();

}

  function I()
{

            var logo = document.getElementById('compass');
            logo.src="Images/1Map.png";
            var hope = document.getElementById('name');
            hope.innerhtml = "Kelvingrove" + "</br>" + "Park";
            Twirl();
}

function Twirl()
{
var tilt=document.getElementById('spin');

            var compass = document.getElementById('compass');
                        if(window.DeviceOrientationEvent) {

                                    window.addEventListener('deviceorientation', function(event) {
                        var LR = event.gamma;
                                    var FB = event.beta;
```

```
					var DIR = event.alpha;
					deviceOrientationHandler(LR, FB, DIR);

				//Check for iOS property
				if(event.webkitCompassHeading) {
							DIR = event.webkitCompassHeading;
							//Rotation is reversed for iOS
							compass.style.WebkitTransform = ‘rotate(-’ + DIR + ‘deg)’;
				}

//non iOS
				else {
					DIR = event.DIR;
					webkitAlpha = DIR;
					if(!window.chrome) {
webkitAlpha = DIR-270;
				}
 }

 function deviceOrientationHandler(LR, FB, DIR) {
				var level=document.getElementById(tilt);
				var tiltAngle = DIR - “360”;
				tilt.style.width = “25%”;
				tilt.style.webkitTransformOrigin = “25% 100%”;
		tilt.style.webkitTransform = “rotate(“+ tiltAngle +”deg)”;
				compass.style.Transform = ‘rotate(‘ + DIR + ‘deg)’;
		compass.style.webkitTransform = “rotate(“+ LR +”deg) rotate3d(1,0,0, “+ (FB*-1)+”deg)”;
		compass.style.MozTransform = ‘rotate(-’ + DIR + ‘deg)’;
				}
},
false);

}
}

</script>
</body>
</html>
```

Appendix H
Member Checking the Results of Analysis and the Contextualised Graphic Syntax

This appendix offers an account of the process of member checking, which took place after an initial version of the enquiry's final contextualised graphic syntax was generated (see Section 6.4). This process was undertaken for two reasons. Firstly, it was felt that member checking might offer a forum wherein the researcher's interpretations could be scrutinised and, if necessary, adapted. Secondly, it was also held that by offering participants an opportunity to react to the framing of the contextualised graphic syntax, member checking would enhance its *credibility* (Lincoln and Guba 1985, see Section 3.1.4.1).

In total, five participants from the final prototype test were interviewed. Thus, almost *one* out of every *four* participants were included in the member checking process. These participants were selected on the basis of their availability (i.e. they could take part), as well as the *meanings* they had ascribed to the prototype. The latter approach was undertaken in order that participants with differing understandings of the design might be consulted. In the end, participants who identified the following list of *meanings* were interviewed: *exploration/wandering* represented by EP#20, EP#32 and, EP#35; *touring* represented by EP#28; and *general wayfinding* represented by EP#34.

At the opening of each member checking interview, the researcher began by offering a brief overview of the methods that were applied in the prototype tests (i.e. qualitative and quantitative data collection and analysis). Thereafter, through a series of mappings, participants were introduced to some of the results, including their own. If they had any questions these were answered immediately.

First off, a single mapping was shown which presented the qualitative and (qualitized) quantitative results for the entire group's use of the prototype. At this point, participants were introduced to their own data for the first time and, then, offered an insight into the results across the group. Thus, they were offered an insight into their own positioning in relation to the whole.

Once the participant appeared satisfied, a more detailed set of mappings were introduced. These grouped participants according to the meaning they had ascribed to the prototype and presented the qualitative and (qualitized) quantitative results from both sections of the test (i.e. in relation to both Google Maps and the prototype). Again, participants were introduced to their own data and then, across the various mappings, provided with an overview of the whole. Attention was here drawn to how their experience of, and behaviour with, both interfaces was seen to contrast or relate.

Lastly, as a final gesture, an initial version of the enquiry's contextualised graphic syntax was presented in visual form. So far as was possible, its general framing and features were explained.

Having guided participants through the above mappings, as well as the contextualised graphic syntax, they were invited to offer their reactions on the whole. If, at this point, further clarification or repetition of any item was required, the researcher ensured that such information was provided. Otherwise the participant was simply allowed to speak for as long as they pleased. Reviewing these contributions, particular attention was paid to how they reacted to their own representation within the data.

In the main participants were appreciative of having been granted the opportunity to view the data and the results of analysis. All appeared intrigued by their own positioning within these results, most especially by how the meaning they had ascribed was seen to relate to those ascribed by others. Though no one objected to how they had been represented, participants EP#20, EP#28 and EP#35 did raise questions, which caused the researcher to reconsider particular positionings and their presentation within this thesis.

Here, EP#20 and EP#28 wondered how they might have experienced the prototype had they been wholly *unfamiliar* with the environment. (Both held a degree of familiarity with the route. This was particularly the case with EP#20). Beyond this, EP#35 noted how she felt the novelty of the interface might have affected her behaviour in use. That is, she felt her interface-environment interactions might be attributable to her lack of familiarity with the *interface*, and wondered if over time this might change.

In order to respond to the contributions of EP#20 and EP#28, a reassessment of the levels of familiarity held by the group was undertaken. Here, a table was produced, separating participants according to whether they were unfamiliar, somewhat familiar or familiar with the route. Against this, the researcher then checked each participant's *experiences with* the prototype and *of* the prototype (see Section 5.4.4). Here, no clear pattern was identified between the level of familiarity held and these latter categories. This was underscored when negative case analysis (see Section 6.1.2.1) revealed that such cases held *variable* levels of familiarity. As such, it was concluded that, for this group, differences in participants' patterns of experience and behaviour (see Section 6.1.1) could not be attributed to familiarity.

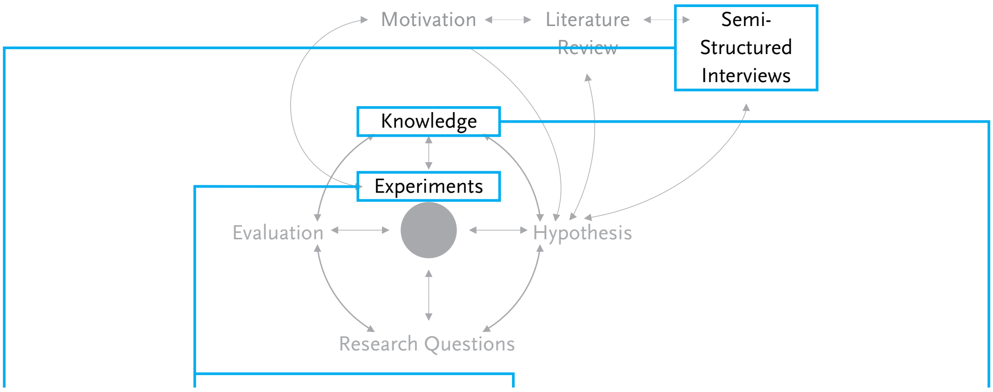
Next, in order to address the point raised by EP#35, it has been noted in the limitations section (Section 7.7.1) that the claims made in relation to this enquiry's artefact and its accompanying contextualised graphic syntax arise from a *single* test cycle. From this—in the future research section (Section 7.8.2)—the need for a longitudinal study, focusing on how an individual's experience and behaviour may adapt over time, has been highlighted. On this latter reframing, it is important to recall that the enquiry's contextualised graphic syntax is presented as non-generalisable from the outset (see Section 3.1.2). As such, its warranted assertability (see Section 3.1.3) is not seen to be undermined.

Thus, though none of the researcher's interpretations were altered and the contextualisation of the graphic syntax remained intact, both a limitation and a direction for future research were identified.

Appendix 1
Audit Trail Map

This appendix presents an audit trail map, with which to access the direct and indirect research material underpinning the enquiry's interviews and experiments (e.g. video and audio recordings, transcripts, and observation notes). It is provided in order to enhance the enquiry's dependability and, thus, its confirmability (see Section 3.1.4.1).

Audit Trail Map



Semi-Structured Interviews

Original audio files
Appendix J,J.1

Qualitative Data

- Interview transcripts
  Appendix J, J.1
- Interview transcripts with analysis
  Appendix J, J.1
- Reduced data from interview transcripts relating to specific questions
  Appendix J, J.1
- Mappings of the analysed interview data relating to specific questions
  Chapter 4, various sections

The Field Simulation Test

Original video files
Appendix J, J.2.1

Qualitative Data

- Open evaluation transcripts with analysis
  Appendix J, J.2.1
- Reduced data from the transcripts relating to specific themes
  Appendix J, J.2.1
- Table outlining how the open evaluations led to abductive responses by the reseacher
  Section 5.3.3

Quantitative Data

- Observation notes
  Appendix J, J.2.1
- Table displaying the observations results
  Section 5.3.5

The Prototype Test

Original video files
Appendix J, J.2.2

Qualitative Data

- Interview transcripts with analysis
  Appendix J, J.2.2
- Tables of the fragments from the interview data relating to specific questions
  Section 5.4.4

Quantitative Data

- Observation notes
  Appendix J, J.2.3
- Diagrams displaying the observation data
  Appendix E
- Table, bar charts and a box plot of the observation data
  Section 5.4.5

Integration and Contextualised Graphic Syntax Generation

Qualitative Data

- Tables demonstrating the process of qualitizing participants' quantified behaviours in the prototype tests
  Appendix E, E.3
- An integrated dataset combining participants' experience of the interfaces with their qualitized behaviour
  Section 6.1.1
- Original audio files of the member checking interviews
  Appendix J, J.2.3
- A reflection on member checking
  Appendix H

1.1 The audit trail map, offering the sections at which particular material may be found.

Appendix J
The Enquiry's Raw and Analysed Data Files

This appendix presents a series of links to the enquiry's raw and analysed data files. The appendix is divided into two sections. The first presents links to the files associated with the research technique applied in enquiry's first phase (i.e. the conducting of semi-structured interviews). The second presents links to the files associated with the particular research techniques applied in the enquiry's second phase (i.e. the undertaking of the design experiments). For an overview of how these files may be seen to connect to the enquiry's methods and, as such, the enquiry as a whole, please turn to Appendix I.

J.1 Raw and Analysed Data Associated with the Semi-Structured Interviews

The below link contains access to:

- Original audio files
- Interview transcripts
- Interview transcripts with analysis
- Reduced data from interview transcripts relating to specific questions

The link:

http://bit.do/semistructuredinterviews

J.2 Raw and Analysed Data Associated with the Design Experiments and Graphic Syntax Contextualisation

This section is divided into three subsections. These provide links to files pertaining to the field simulation test, the prototype test, and member checking in turn.

J.2.1 *Raw and Analysed Data Associated with the Field Simulation Test*

The below link contains access to:

- Original video files
- Interview transcripts with analysis
- Reduced data from interview transcripts relating to specific themes
- Observation notes

The link:

http://bit.do/fieldsimulation

J.2.2 *Raw and Analysed Data Associated with the Prototype Test*

The below link contains:

- Original video files
- Interview transcripts with analysis and observation notes

The link:

http://bit.do/prototypetest

J.2.3 *Raw Data Associated with Member Checking in the Generation of the Contextualised Graphic Syntax*

The below link contains:

- Original audio files

The link:

http://bit.do/membercheck

Appendix K
Video of the Final Prototype

A video demonstrating the prototype is available for viewing at:

http://bit.do/prototypevideo

(The video may also be accessed on the Memory Key found on the inside of the front cover of this thesis). The below figures offer a series of stills from the video.

Fig. K.1 The title sequence at the opening of the video.

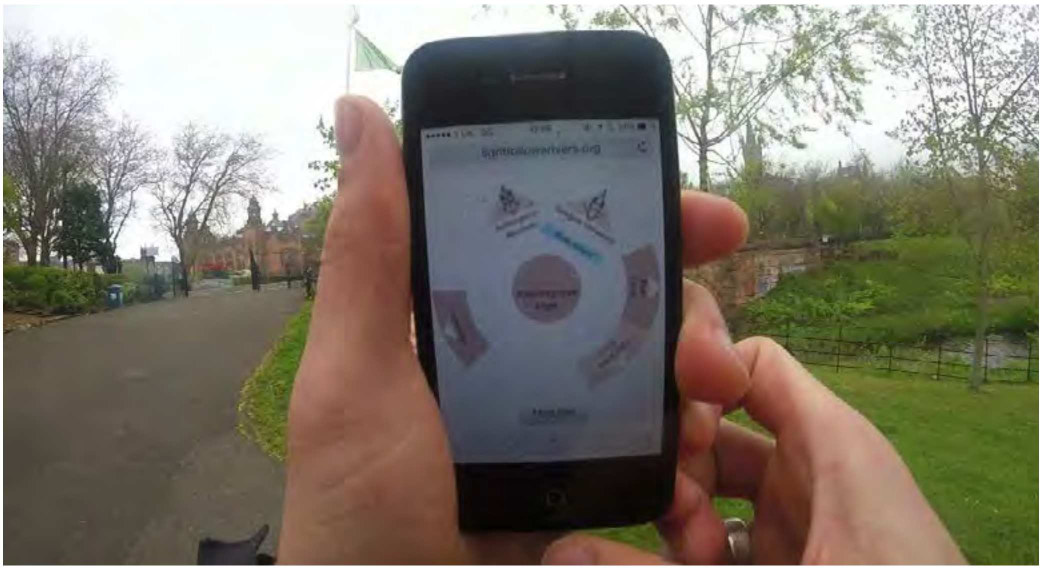


Fig. K.2 The first use of the prototype in the video.

Fig. K.3 The second use of the prototype in the video, as the researcher begins to walk.

Fig. K.4 The researcher begins to explore the rotation of the prototype in their third use.

Fig. K.5 The researcher walks along the test-route between their third and forth use of the prototype.

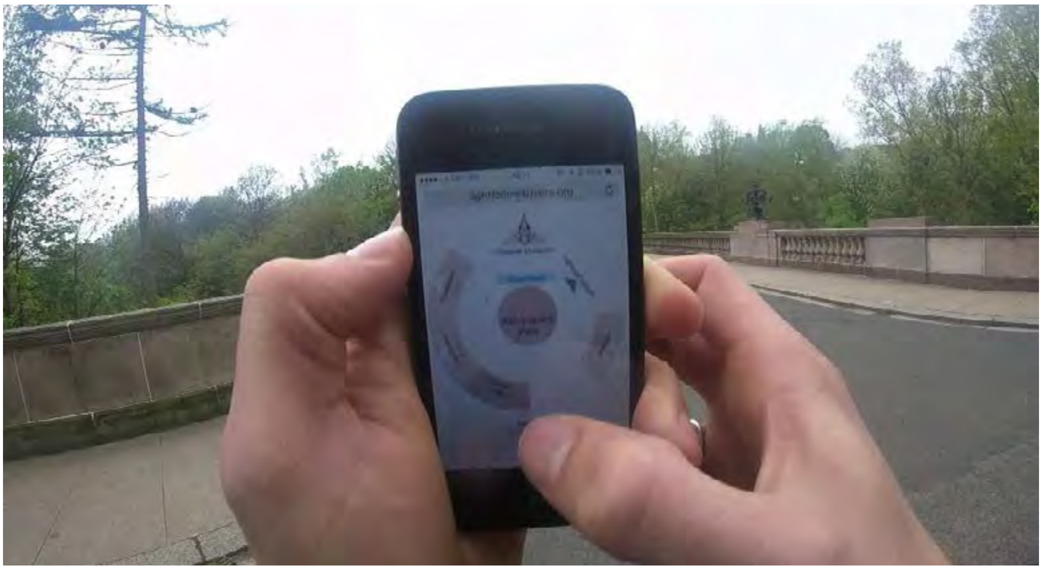


Fig. K.6 The researcher uses the prototype for the fourth time. A pictorial representation of Glasgow University appears at the top of the screen; the building is covered by the mobile telephone.

Fig. K.7 The researcher walks along the test-route, between their fourth and fifth use of the prototype.

Fig. K.8 The researcher uses the prototype for the fifth time. A pictorial representation of Hillhead school appears at the top of the screen; the building is just visible behind the mobile telephone.

Fig. K.9 The researcher walks along the test-route, between their fifth and sixth use of the prototype.

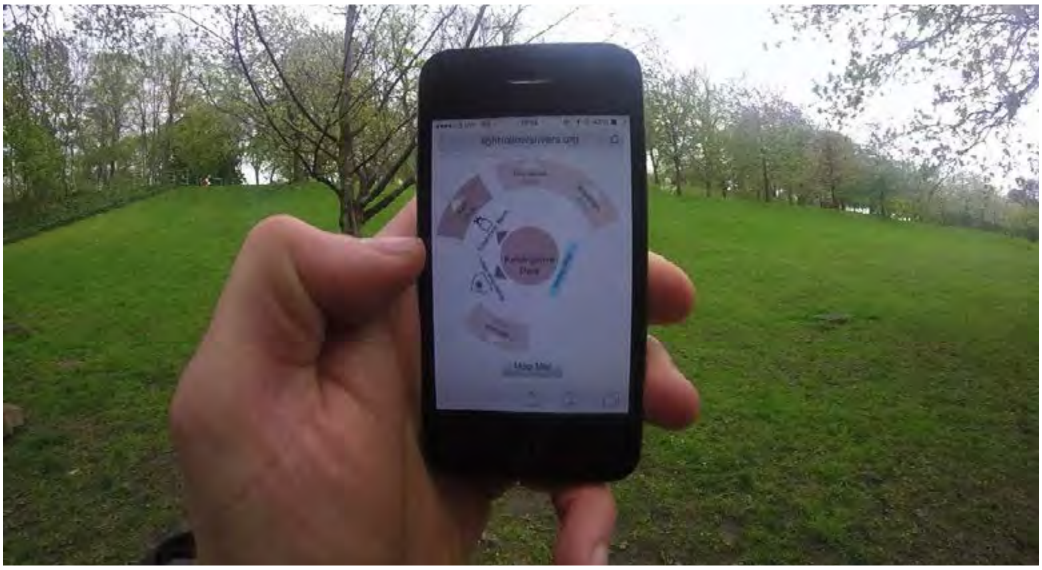


Fig. K.10 The researcher uses the prototype for the sixth time. Pictorial representations of the Robertson Memorial and St. Silas Church appear on the screen; the features are visible beyond the frame.

Fig. K.11 The researcher walks along the test-route, between their sixth and seventh use of the prototype.

Fig. K.12 The researcher uses the prototype for the seventh time. A pictorial representation of St. Silas Church appears at the top of the screen; the building is covered by the mobile telephone in the frame.

Fig. K.13 The closing sequence at the end of the video.